OPERATING AND SERVICING MANUAL FOR AC LINE VOLTAGE REGULATOR MODEL 760

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PART OF AC PROGRAMMABLE SIGNAL GENERATOR MODEL 700

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OCONTO, WISCONSIN

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The schematic diagram appears after page 6-24.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or it is damaged in any way, a claim should be filed with the carrier. Also, notify Holt Instrument Laboratories or the local representative immediately. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Holt Instrument Laboratories warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electron tubes, fuses, and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid, and when upon our examination it is to our satisfaction defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify either the factory or the area Holt representative, giving full details of the difficulty, and include the model and serial numbers. Upon receipt of this information we will give you service data or shipping instructions.

2. On the receipt of shipping instructions, forward the instrument prepaid to the factory or the authorized repair station indicated in the instructions. If requested, an estimate of the charges will be made before the work begins if such work is not covered by warranty. All shipments of Holt Instrument Laboratories' equipment should be packed in a strong exterior container surrounded by two or three inches of shock absorbing material.

SECTION 1
INTRODUCTION

1.1 General Description

a. The Holt AC Line Voltage Regulator Model 760, a self-regulating power supply unit capable of supplying up to 1 KVA of pure sine wave 60 cycle voltage output, is adjustable between 110 and 120 volts from an AC power line whose voltage may vary between 95 and 135 volts.

b. The Model 760 provides 100 db of isolation between the input and output circuits while providing 40 db of harmonic attenuation and 40 db of transient rejection. The line and load regulation of the Model 760 is within 0.1%.

c. The Model 760 incorporates circuitry to protect it from damage should an overload be accidentally applied. The regulator is rated at 9 amperes RMS. It is provided with long term protection circuitry including a magnetic circuit breaker. Loads of 12 amperes or more applied for more than 300 milliseconds will trip the magnetic circuit breaker turning the regulator off. The regulator is so designed that 25 ampere short term transients will trip the protection circuitry. Currents greater than 9.5 amperes drawn for more than 3 seconds will switch the regulator to a standby condition while maintaining line power to the load.

d. The front panel controls of the Model 760 allow the operator to select any output voltage from 110 to 120 volts AC. Two front panel meters allow the operator to monitor output voltage and current as well as input voltage.

1.2 Technical Specifications

Specifications for the Holt AC Line Voltage Regulator Model 760 are included as a part of the technical specifications for the Model 700 AC Programmable Signal Generator and will be found in the Model 700 manual.

Figure 1. AC Line Voltage Regulator - Model 760

SECTION 2
OPERATING INSTRUCTIONS

2.1 Preparation for Use

a. General. The Model 760 AC Line Voltage Regulator is supplied, factory tested and calibrated, in a single shipping container. The unit should require no preliminary service by the customer other than the removal of top and bottom chassis covers to permit inspection. Be sure that the plug-in boards are securely mounted and undamaged. Inspect all plug and jack connections for proper mating.

b. Grounding. Certain ground connections, as well as the regulator output, are brought out to the connectors (J601 and J603) on the rear panel. Other ground points are as follows:

(1) Primary Shield. The primary shield connects to a shield for the primary winding in the isolation transformer (T1). This terminal is internally connected to the regulator input cord ground wire and appears as a third prong on the input plug.

(2) Secondary Shield. The secondary shield connects to the shield for the secondary winding in isolation transformer (T1).

(3) Regulator Ground. The regulator ground is internally connected to the low side of the regulator output circuit and is labeled TP1 on the schematic diagram.

(4) Chassis Ground. The chassis ground is connected directly to the chassis of the regulator. In normal use, grounding is accomplished through the cables supplied with the Model 700. If the regulator is not rack mounted or if the rack is not grounded, chassis ground can be connected to the customer's system ground or to other test equipment in use.

c. Grounding Recommendations. The AC power line connections for the Model 700 system are made through the two Model 760 AC line voltage regulators. Refer to the Model 700 system manual for the recommended grounding procedures.

d. Power Connections. AC line connections to the Model 760 are made through conventional three wire AC line cord. The input power line frequency must be within ± 1 cycle per second of a 60 cycle frequency and input voltage must be between 95 and 135 volts AC. A three position switch on the back panel must be set to one of the three input voltage ranges 95 to 115 volts, 105 to 125 volts, or 115 to 135 volts. The Model 760 draws a maximum of 12 amperes from the AC line at full load.

e. Operating Temperatures. The Model 760 contains a number of semi-conductor devices mounted on heatsinks and cooled by a fan. Do not attempt to operate the instrument with less than one inch of

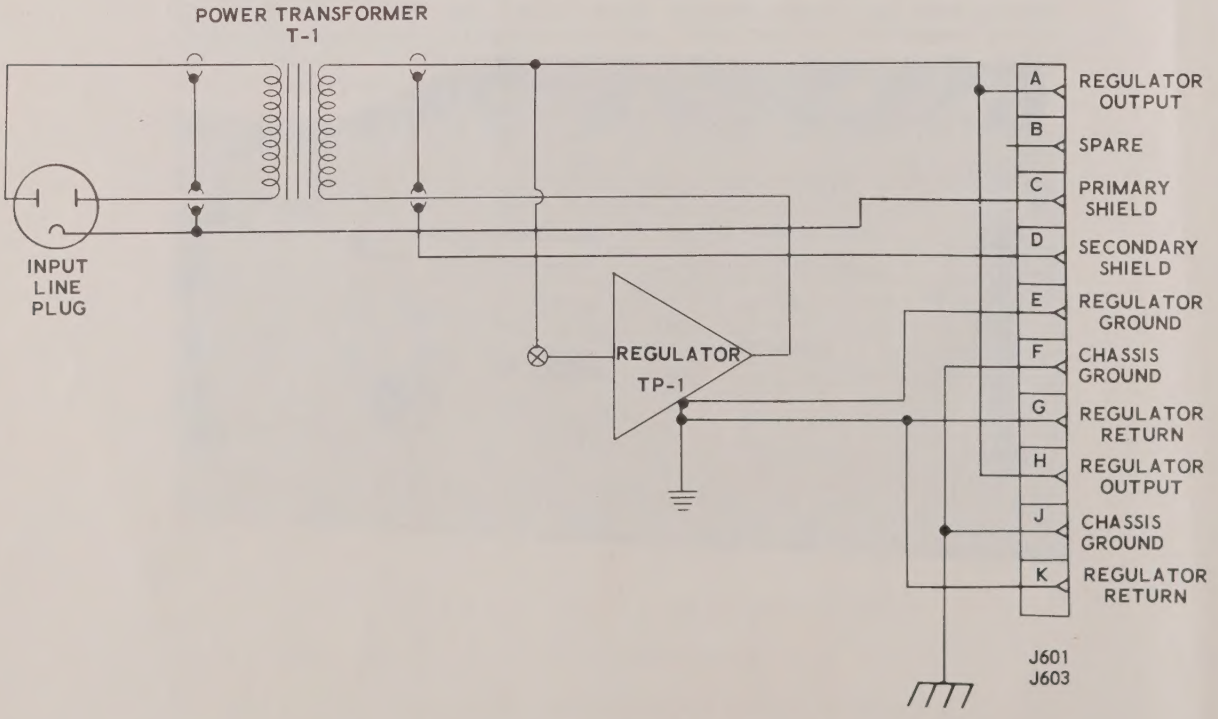


Figure 2. Model 760 Grounding System

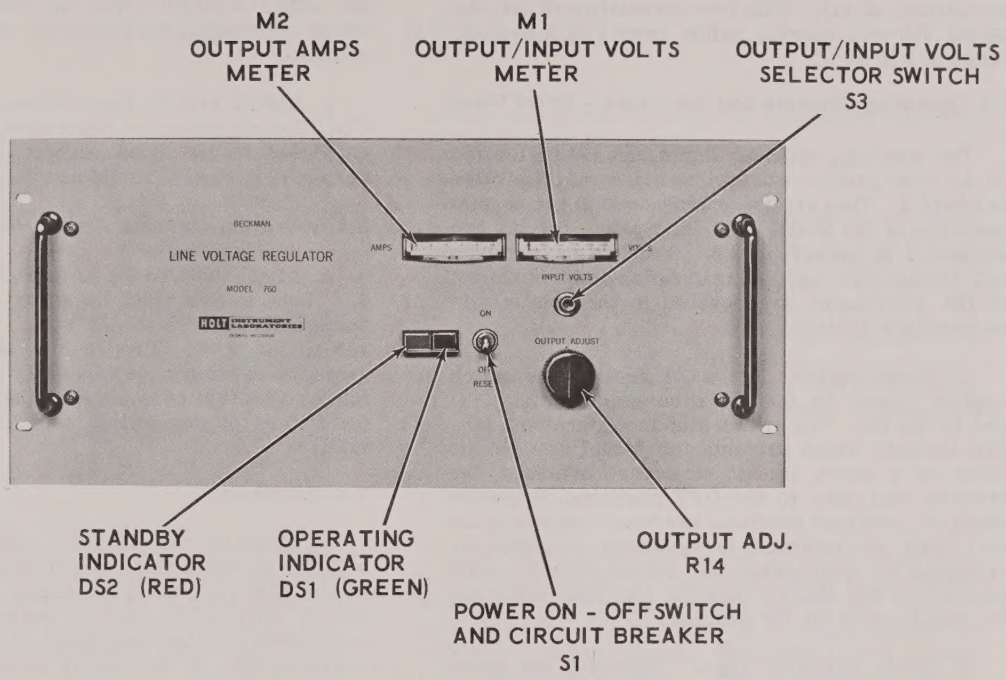


Figure 3. Front View - Model 760

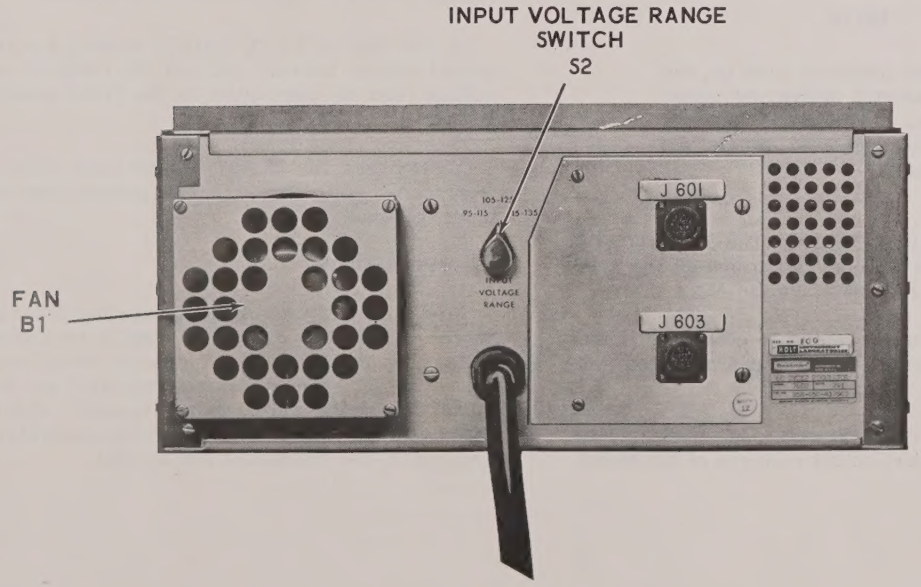


Figure 4. Rear View - Model 760

air space at the top and bottom to provide for free circulation of air. With free circulation of air, the Model 760 will operate safely over a temperature range of 0 to 40° C.

2.2 Operating Controls and Indicators - Front Panel

The controls, indicator lights, and meters located on the front panel are described below and illustrated in figure 3. They are the controls used in the normal operation of the Model 760. Rear panel controls are discussed in paragraph 2.3. The internal controls and adjustments used in calibration and adjustment of the instrument are covered in the appropriate maintenance section.

a. Power Switch. In the ON position, the switch applies power to the isolation transformer (T1) and to the fan. The switch also incorporates a circuit breaker which protects the Model 760. In the event of a short circuit or severe overload, the breaker will trip to the OFF position. When the short or overload condition has been corrected, the unit may be returned to operating condition by momentarily depressing the switch past the OFF position to the RESET position and then returning the handle up to the ON position.

b. Green Indicator Light. When lit, the green indicator light shows that the regulator is functioning correctly.

c. Red Indicator Light. When lit, the red indicator light indicates that power is applied to the regulator unit but that the regulating portion of the unit is no longer functioning. This may occur during the warm-up period or in the event of regulator overload.

NOTE

With the red indicator light on, the Model 760 is still delivering power to the output circuit but the output is not being regulated within the specified limits.

d. OUTPUT ADJUST Control. The OUTPUT ADJUST control allows the operator to select any output voltage between 110 and 120 volts AC.

e. Ammeter. The ammeter is connected in the output circuit and reads the current drawn from the Model 760.

f. Voltmeter. The voltmeter is connected to monitor both input and output voltages of the Model 760. Under normal operating conditions, it monitors the output voltage. With the INPUT VOLTS push button depressed, the voltmeter reads the input line voltage.

g. INPUT VOLTS Push Button. When the INPUT VOLTS push button is depressed, the voltmeter is connected to the input circuit and reads the line voltage delivered to the Model 760.

2.3 Operating Controls - Rear Panel

a. INPUT VOLTAGE RANGE Switch - see figure 4. This switch must be set to one of three input voltage ranges: 95 to 115 VAC, 105 to 125 VAC, or 115 to 135 VAC. Proper positioning of this switch gives the regulator the capability of providing maximum regulation over a wide input range. Improper positioning of this switch may result in instrument failure.

2.4 Operation

a. Measure the available line voltage with a suitable AC voltmeter. The voltage must be between 95 and 135 volts, 60 cycle, single phase AC. Set the INPUT VOLTAGE RANGE switch, located on the back panel, so that the value of the line voltage is approximately in the center of one of the three operating ranges.

b. Plug in the regulator input cord. Turn the ON-OFF switch on the front panel to ON. The red indicator should light immediately. While the red indicator light is ON, raw AC line voltage is applied to the load. After approximately two seconds, the red light will extinguish and the green indicator light will come on. A pure regulated 60 cycle sine wave voltage is now being delivered to the load.

c. Set the OUTPUT ADJUST control for any required voltage between 110 and 120 volts AC. Output voltage can be monitored on the front panel voltmeter.

d. Depress the INPUT VOLTS push button. The front panel voltmeter will now indicate the AC line input voltage.

2.5 Applications

The Model 760 AC Line Voltage Regulator is used in the Model 700 system to supply regulated line voltage to the remaining elements which make up the system. No individual applications for the Model 760 will be given in this manual. For applications of the Model 700 AC Programmable Signal Generator, see the Model 700 manual.

SECTION 3
THEORY OF OPERATION

3.1 General Theory

a. In its simplest terms, the Model 760 consists of an isolation transformer (T1), an AC reference, and an error amplifier. See the simplified block diagram, figure 5.

b. The unregulated AC line voltage is applied to the primary of transformer (T1). Since transformer (T1) is a step-up transformer, a somewhat higher voltage is produced across each secondary. The lower secondary applies a 180° out of phase voltage to the AC reference. The output of the AC reference is a clean sine wave. If the output of the isolation transformer secondary (TP3) is now compared to the output from the AC reference pack at the summing junction, the resulting voltage will be the difference between the AC reference and the output voltage, an error signal. This error signal is now amplified and properly phased to subtract from the secondary output voltage and thus produce the regulated line output. A subtractive method of regulation gives the regulator a better capability to deal with low line voltage. When the line voltage is low, the regulator power supply voltage is low also. If the regulator corrections were normally added to the induced voltage instead of subtracting when the line voltage is low, the power supplies would be taxed to their limit to correct the output voltage. By subtracting, the low line voltage requires less subtraction from the transformer voltage thus permitting the power supplies to adequately deal with harmonics and transients.

b. A more detailed block diagram of the basic theory of Model 760 will be found in figure 6. In this diagram, the AC reference is divided into its component parts of an axis amplifier, a filter, and an output adjust circuit. The error amplifier, in turn, consists of a high gain pre-amplifier, a driver amplifier, and a pair of output amplifiers. In order to maintain the required reference levels in these various circuits, three power supplies are required.

3.2 Basic Circuit Theory

The paragraphs that follow will each be devoted to a discussion of the operating theory of one of the basic circuits that make up the Model 760. The entire circuitry will be found on a single schematic at the rear of the manual. This schematic is divided into individual circuits, each corresponding to a single printed circuit board in the Model 760. Each circuit discussion will cover one circuit board so far as possible, although the interconnection of circuit boards will require reference to more than one circuit diagram in some cases. Refer to the basic block diagrams, figures 5 and 6, to better understand the position and function of each circuit in the action of the Model 760.

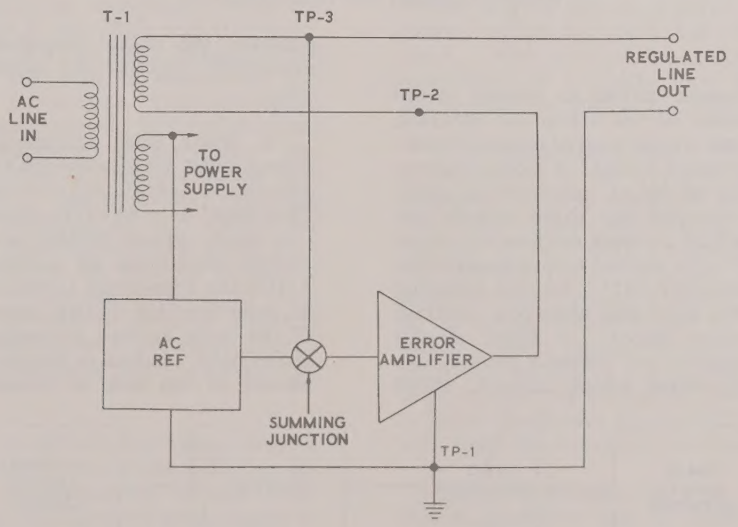


Figure 5. Simplified Block Diagram

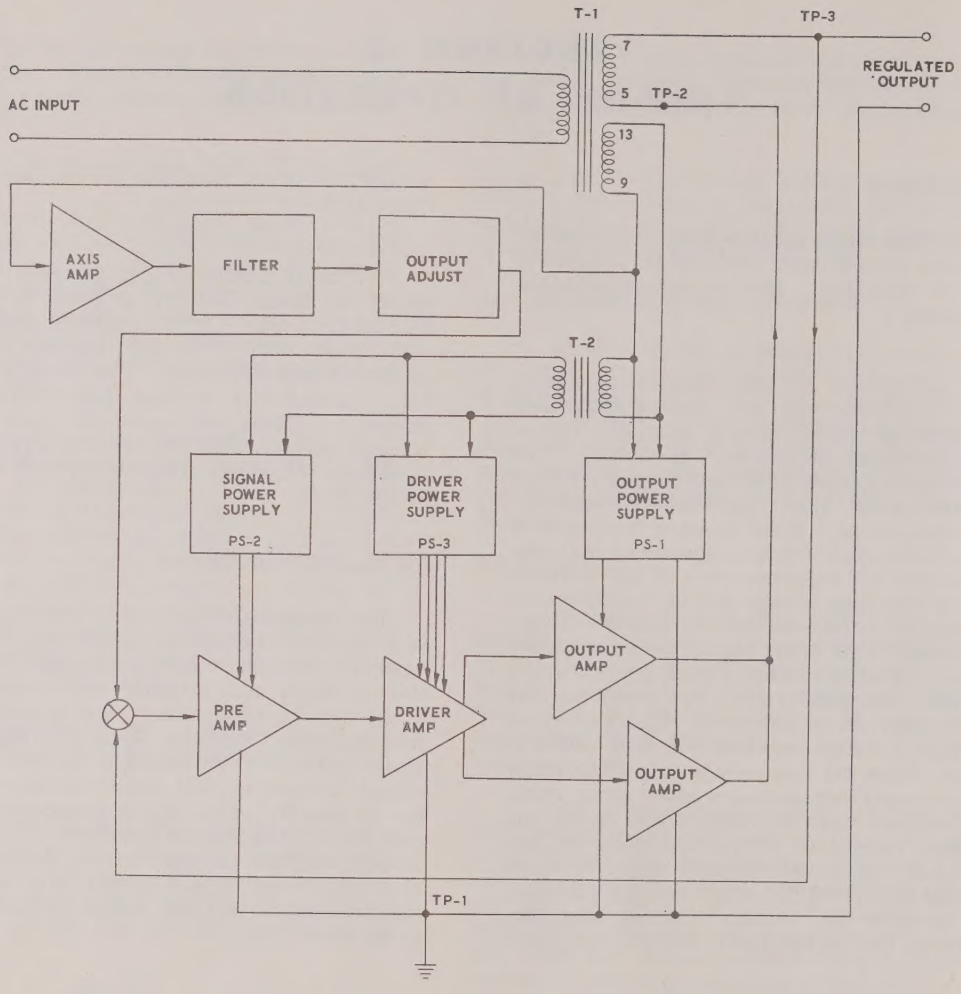


Figure 6. Model 760 Block Diagram

3.3 AC Reference

a. The AC reference circuit is located in the lower left hand corner of the schematic diagram and consists of the two circuit boards labeled Reference 1 (A7) and Reference 2 (A8). A block diagram of the circuits making up the AC reference is illustrated on figure 7. Note that four basic circuits are involved. A phase adjust network enables the phase of the input voltage to be shifted to compensate for phase shift in transformer (T1). An axis crossing amplifier converts the input sine wave to a constant amplitude square wave output. A filter circuit eliminates the harmonics and leaves a pure 60 cycle sine wave. An output adjust circuit, which contains the output amplitude front panel control, effectively controls the output voltage of the Model 760.

b. Phase Shift Circuit (Circuit Board A7). A signal input from isolation transformer (T1) enters Reference Circuit (A7) at the terminal marked L. This input is a 60 cycle signal in phase with the AC line input. Phase shifting is accomplished by an RC circuit consisting of resistors (A7R1, A7R2, and A7R3) and capacitors (A7C1 and A7C2). Adjustment of potentiometer (A7R2) permits shifting the phase of the input voltage to correct for the transformer phase shift. Output of the phase shift circuit is connected to the base of transistor (A7Q1), the first

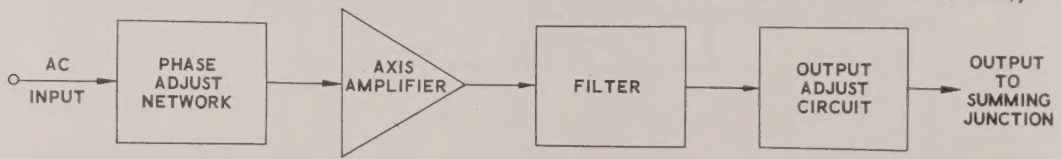


Figure 7. AC Reference Circuit Block Diagram

stage of the axis crossing amplifier. A diode (A7CR1), connected from the base of the transistor to ground, protects the transistor from excessive back voltage.

c. Axis Crossing Amplifier (Circuit Board A7). The input to the axis crossing amplifier is a sine wave that is in phase with the regulator input. This sine wave input voltage is amplified by transistor (A7Q1) and applied to base of a switching transistor (A7Q2). The sine wave voltage will switch transistor (A7Q2) either ON or OFF to produce an output square wave. When A7Q2 is switched ON, current flows through the transistor and through A7R11 making the output approximately 1/2 volt negative. When transistor (A7Q2) is switched OFF, current is drawn through the zener diode (A7CR3) making the output approximately 5 volts negative.The values of resistors (A7R7 and A7R11) are factory adjusted so that the impedance of the zener diode during the OFF condition is exactly equal to the impedance of A7R11 during the ON condition. In this balanced condition, the peak-to-peak amplitude of the square wave produced is independent of the power supply voltage and of the input line voltage, and is dependent only upon the characteristic voltage of the zener diode. This constant amplitude square wave, produced by the switching transistor A7Q2 is now applied to the base of transistor A7Q3. Transistors (A7Q3 and A7Q4) form an emitter follower circuit. A7Q3 is the emitter follower proper while A7Q4 functions as a constant current source. This type of emitter follower stage has a higher input impedance, greater load driving capability, and lower distortion than a conventional emitter follower employing an emitter resistor. Output of the emitter follower is taken from terminal S and applied to the filter circuit.

d. Filter Circuit (Z1). The function of the filter circuit is to eliminate the harmonics from the square wave and leave a pure 60 cycle sine wave. This is accomplished by a two stage, stagger tuned filter whose overall response is essentially flat from 59 to 61 cycles per second. This flat-topped response allows the line frequency to vary somewhat without affecting the efficiency of the filter. The output of the axis amplifier is connected to the first filter stage at terminal 1. The first filter stage has maximum amplitude response at 41.7 cycles per second. Output of the first filter stage is taken from terminal 3 and applied to the base of transistor (A7Q5). Transistors (A7Q5 and A7Q6) make up an emitter follower circuit that is identical to that of A7Q3 and A7Q4 discussed above. The various emitter followers provide isolation between filter sections and their loads.

Output from A7Q5 is applied to a voltage divider formed by A8R2 and A8R4. The voltage divider attenuates the signal to compensate for the gain of the filter stages and keeps the signal at good amplitude for the emitter followers. Output of this voltage divider is applied to the base of transistor (A8Q1). Transistors (A8Q1 and A8Q2) are also connected in an emitter follower configuration. The output of A8Q1 is applied to the second stage of the filter at terminal 4.

The second stage of the filter has maximum amplitude response at 73 cycles per second. The two cascaded filter stages form a staggered tune band pass filter that is flat in both phase and amplitude from 59 to 61 cycles per second. The output of the second filter stage taken from terminal 6 is applied to the base of transistor (A8Q3). Transistors (A8Q3 and A8Q4) make up another emitter follower circuit similar to those discussed previously. The output of this emitter follower drives the regulator output adjust circuit.

e. Output Adjust Circuit. The output adjust circuit is essentially a resistive voltage divider in which resistors (A8R9 and A8R10) are used to set the operating range of potentiometer (R14). R14 is the front panel OUTPUT ADJUST control. This OUTPUT ADJUST control sets the output voltage of the Model 760 by controlling the amplitude of the AC reference voltage. Output from the arm of R14 is applied to another emitter follower circuit made up of transistors (A8Q5 and A8Q6). It is the output of this emitter follower stage, coupled through condenser (A8C5), which makes up the AC reference voltage signal applied to the summing junction.

3.4 Error Amplifier

a. The error amplifier circuit is located in the left center of the schematic diagram and consists of the three circuit boards labeled Amplifier No. 1 (A4), Amplifier No. 2 (A5) and Amplifier No. 3 (A6). A block diagram of the circuits making up the error amplifier is illustrated in figure 8. Note that six basic circuits are involved in the error amplifier: a high gain pre-amplifier with a shaped frequency response which is maximum at 60 cycles; an inverter circuit which is a low gain class A amplifier whose only function is to invert the signal; a pair of driver amplifiers; and a pair of power output amplifiers. The sum of the outputs of the two output amplifiers is a single sine wave which is out of phase with the input to the error amplifier.

b. Pre-Amplifier (A4). The input signal to the pre-amplifier is the error signal developed at the summing junction (terminal E on Amplifier No. 1). The action of the entire feedback loop is to keep this junction at very nearly zero potential at all times. The output of the AC reference is fed into this summing junction through resistor (A4R1). A sampling of the output voltage from TP3 is fed into this summing junction through resistor (A4R6). Since the reference voltage is a clean sine wave, the amplifier must correct the voltage at TP3 to a clean sine wave in order to achieve the cancellation of currents that will keep the summing junction voltage near zero.

The pre-amplifier itself is a linear class A transistor amplifier with a clearly shaped frequency response. The frequency of maximum gain is 60 cycles. At 60 cycles, the forward voltage gain of the pre-amplifier is approximately 1000. This frequency response shaping is achieved by minor loop feedback around each of the three amplifier stages

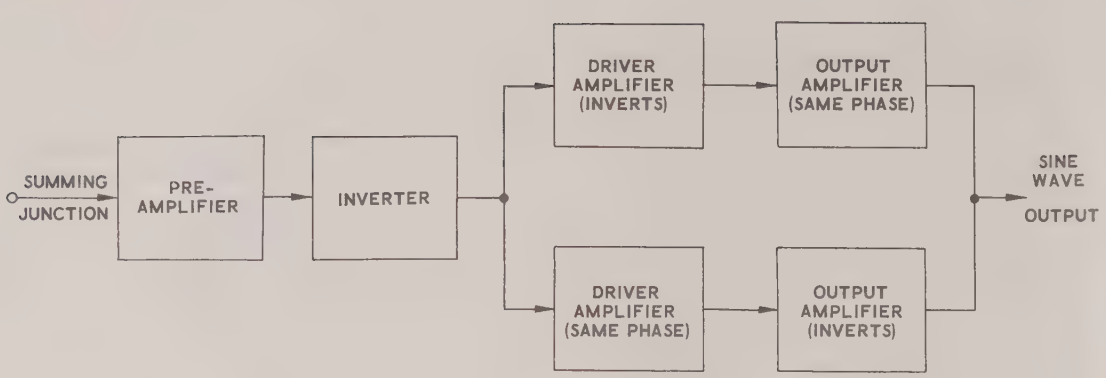


Figure 8. Error Amplifier - Block Diagram

which make up the pre-amplifier circuits on circuit boards A4 and A5. The first two feedback networks are sharply tuned bridged "T's." The third feedback network is a broadly tuned bridged "T." The center frequency of all these bridged "T" networks is 60 cycles per second. Shaping the frequency response of the pre-amplifier achieves high loop gain at 60 cycles per second without the possibility of oscillation at high frequencies. High loop gain at 60 cycles per second is necessary in order to achieve the very low output impedance and the very tight regulation against line and load changes that are specified for the Model 760.

The input signal from the summing junction is applied to the base of transistor (A4Q2) an emitter follower circuit. Use of an emitter follower input serves to increase the input impedance of the amplifier. Transistors (A4Q3 and A4Q4) form the first stage of amplification, A4Q3 acting as a transistor amplifier while A4Q4 acts as an emitter follower. The first of the bridged "T's", or notched filters, connects the emitter of A4Q4 back to the base of A4Q3. Since the filter is tuned for 60 cps, there is very little feedback and the gain of the stage at 60 cycles is 10. At frequencies other than 60 seconds, the feedback increases as a function of frequency until the gain is reduced to approximately 1.

Output of A4Q4 is fed to a combination of transistors (A4Q5 and A4Q6) which are identical to A4Q3 and A4Q4 discussed above and which incorporate the second bridged "T" feedback network. Output from the emitter of A4Q6 is fed to the third stage of amplification consisting of transistors (A5Q1 and A5Q2). This third stage differs from the first two stages in that the amplifying transistor is an NPN type and the emitter follower is a grounded collector circuit. This allows the output of the third stage to be directly coupled into A5Q5. Also the bridged "T" circuit employed in the third stage is more broadly tuned than those used in the first two stages. The gain of the third stage is 10 over the flat portion of the filter, resulting in an overall pre-amplifier gain of 1000 at 60 cycles per second.

c. Inverter. Output of the pre-amplifier stage taken from the emitter of A5Q2 is fed into the base of transistor (A5Q5) the inverter stage. A5Q5 inverts the signal, amplifies it, and couples it directly to the bases of transistors (A5Q3 and A5Q4) which are employed as a push-pull emitter follower. An additional input to the bases of A5Q3 and A5Q4 is supplied through capacitor (A5C4). This additional input signal is in the form of feedback from the output amplifiers. The emitters of A5Q3 and A5Q4 are interconnected and the output from this common emitter connection is applied to the driver amplifiers at terminal H on amplifier No. 3 (A6).

d. Driver Amplifier. Reference to the block diagram, figure 8, will show that there are two driver stages. The lower driver stage accepts the sine wave input and produces a negative half wave output corresponding to the negative portion of the sine wave. The upper drive stage accepts the sine wave input and produces a negative half wave output that corresponds to the positive portion of the sine wave. (The lower stage produces an output of the same phase as the input while the upper stage inverts the input signal.) The lower stage signal will be referenced to a +45 volt line while the upper stage signal will be referenced to the potential of the amplifier output (TP2). Both driver amplifier stages operate as class B amplifiers.

The lower driver amplifier consists of transistors (A6Q4 and A6Q7). The input from the inverter stage is coupled to the emitter of A6Q4 through resistor (A6R10). The collector of A6Q4 and the base of A6Q7 are directly connected and tied to the +45 volt line. Thus, the collector of A6Q4 and the base of A6Q7 are both floating at +45 volts. Any signal passed through A6Q4 will be superimposed on the +45 volts. Transistor (A6Q7) is an emitter follower. The output from the emitter is a negative half wave, corresponding to the negative portion of the input sine wave and referenced to +45 volts. This output signal is applied to terminal 10 on the output amplifier heatsink (A11).

A signal from the inverter is applied through A6R9 to the upper driver amplifier at the emitter of transistor (A6Q2). Diode (A6CR2) shunts the negative portion of the sine wave to ground. The output from the collector of A6Q2 is connected directly to the

base of transistor (A6Q5). This common connection is tied (through A6R13 and A6CR7) to the mid-point of two diodes (A6CR6 and A6CR8) that are connected back-to-back. The cathode of A6CR6 is returned to -10 volts, while the cathode of A6CR8 is returned to -12 volts, thus, the collector of A6Q2 and the base of A6Q5 are floating at whichever point is the more negative -10 volts referenced to ground or -12 referenced to the amplifier output. Transistor (A6Q5) is an emitter follower circuit whose output is connected to the base of transistor (A6Q6), used as an inverter. The base of A6Q6 is returned through A6R17 to the amplifier output, thus, any signal passed by A6Q5 will be superimposed on the amplifier output. The output of A6Q6, taken from the emitter circuit, is a negative half wave of voltage referenced to the amplifier output (TP2) and corresponding to the positive half of the input sine wave. It is supplied through A6R22 to terminal 1 on the output amplifier heatsink (A11).

e. Output Amplifier. The output amplifier consists of two circuits shown on the diagram as heatsink (A11).

Output of the lower driver amplifier is applied to the base of transistor (A11Q2) connected as an emitter follower. Output, from the emitter circuit, is applied to the base of transistors (A11Q8, A11Q12, and A11Q16). The collectors of these transistors are tied to the emitters of transistors (A11Q7, A11Q11, and A11Q15). These six transistors, connected together, act as one large transistor to handle the high power dissipation required by the output amplifier. The emitters of (A11Q8, A11Q12, and A11Q16) are connected to the +45 volt line, while the collectors of A11Q7, A11Q11, and A11Q15 are tied to the amplifier output (TP2). The negative half wave signal turns on all six transistors, resulting in a positive half wave of voltage being applied to TP2. Transistor (A11Q4) is an emitter follower circuit which provides a low impedance base drive to turn on transistors (A11Q7, A11Q11, and A11Q15).

The top output amplifier functions much the same as the lower section. The negative half wave signal from the driver amplifier passes through the emitter follower (A11Q1) and is applied to the bases of transistors (A11Q6, A11Q10, and A11Q14). Transistors (A11Q5, A11Q9, and A11Q13) function in the same manner as their counterparts in the lower amplifier. In the upper amplifier, the output applied to TP2 is taken from the emitter of the lower set of transistors, resulting in a negative half wave of voltage being applied to TP2.

At the output of the amplifier (TP2) the two half wave signals from the output amplifiers are summed, resulting in a sine wave of voltage that is 180° out of phase with the error amplifier input.

3.5 Power Supplies

a. General. Reference to the overall block diagram of the Model 760 on figure 6 will show that the power requirements of the Model 760 are satisfied by the use of three basic supplies: a high current supply for the output power amplifier; a signal power supply, and the driver power supply. Each of these power supplies is discussed in a paragraph below.

b. The high current power supply is a conventional bridge type rectifier connected to terminals (9 and 13) on isolation transformer (T1). The four bridge rectifiers are located on the diode mounting plate (A1). Output of the bridge rectifier is filtered by capacitors on Power Supply No. 1. Two output lines from the filters supply voltages of +45 volts and -45 volts.

c. Signal Power Supply. The signal power supply is located on the Power Supply No. 2 circuit board (A9). This circuit provides outputs of plus and minus 15 volts unregulated and plus and minus 10 volts regulated. Transistor (A9Q1) and diode (A9CR2) and their associated circuitry form a constant current circuit that regulates the current to approximately 300 milliamps. Transistor (A9Q2) is used in a series pass circuit. Any change in voltage on the +10 volt line will be sensed by transistor (A9Q3), compared to the 10 volt reference across zener diode (A9CR3) and the resulting error voltage is used to vary the base drive to A9Q2 thus controlling the output voltage. Transistor (A9Q5) and diode (A9CR8) also form a constant current generator. Transistor (A9Q4) is the voltage change senser that drives A9Q2. A9Q2 is the voltage control for the -10 volt output. The plus and minus 15 volts is taken across the filter capacitors (A10C3 and A10C4), located on the Power Supply No. 3 board (A10).

d. Driver Power Supply. The driver power supply is essentially two bridge rectifier supplies, both located on the Power Supply No. 3 circuit board (A10). These two supplies are identical bridge rectifiers with capacitor input filters, each supplying output voltages of +12 and -12 volts. Output of one supply is from terminals B and C with the power supply common (from terminal A) returned to +45 volts. Output of the other supply appears on terminals M and L with its common (terminal N) returned to the amplifier output (TP2).

3.6 Control and Protection Circuit

a. General. The control and protection circuit has four main functions:

(1) To protect against overvoltage demands.

(2) To protect against overcurrent demands (currents in excess of 30 amps peak and 9 amps continuous).

(3) To protect against shorted loads.

(4) To control the red and green indicator lights on the front panel.

When the regulator is operating normally (in the green light condition) and the load becomes such that

the regulator is required to produce more than its rated current or voltage, the control and protection circuit will become activated. When activated, the protection circuit will do two things. First, it will connect the tap on T1 (14) to ground, causing T1 to operate as a 1:1 isolation transformer with no regulated output. Second, it turns the pre-amplifier and driver amplifiers off. At the same time that the above operations are performed, the control circuit turns the green indicator light OFF and the red indicator light ON. After approximately two seconds, the regulator will attempt to return to the regulated green light condition. If the excess load has been removed, the regulator will again become operational. If the excess load is still present, the regulator will remain in the red light condition. This sequence will continue to occur every two seconds until the excess load is removed.

NOTE

If the above red and green light sequence continues AFTER the removal of load, the instrument is malfunctioning.

b. Most of the control circuit wiring is located on the CONTROL circuit board (A3). The overcurrent and average current sensing signal is taken from test point (TP17) and connected to the control circuit board at terminals J and H. The sensing signal is applied to the base of transistors (A3Q1 and A3Q2). These two transistors form a monostable multivibrator circuit. This circuit is arranged to trigger if the current reaches a 30 amp peak or if the average current reaches a value of 9.5 amperes continuously for five seconds. The monostable multivibrator controls a flip-flop circuit formed by transistors (A3Q3 and A3Q4). This flip-flop, in turn, controls transistors (A3Q5 and A3Q6). Under green light conditions, the monostable circuit is ON. In the event of an overload, A3Q1 is switched OFF. This, in turn, causes the flip-flop to switch OFF, turning off transistor (A3Q5). When A3Q5 turns off, it does two things. First, it turns A3Q9 off, which turns the green light OFF. Second, it turns A3Q7 ON which, in turn, switches A3Q8 ON and turns the red light ON.

The same signal which turned A3Q5 OFF will switch transistor (A3Q6) to ON. A3Q6 controls the action of transistor (A3Q10) which, in turn, controls the action of the silicon controlled rectifier (A1CR6). Action of the circuit is such that A3Q6, A3Q10, and the silicon control rectifier (A1CR6) will all turn on and off together.

The function of the silicon control rectifier is to connect pin 14 of the isolation transformer (T1) to ground during red light conditions, thus using the power transformer as a 1:1 isolation transformer and bypassing the regulator. The silicon control rectifier will not conduct until a positive voltage is applied to the control lead from transistor (A3Q10). When transistor (A3Q10) is turned on, +12 volts is coupled through the transistor to the control lead of the silicon control rectifier, causing it to conduct, and thus to effectively connect the tap on the secondary of T1 to ground.

In the overload or red light condition, A3Q5 was turned off. A lead from the collector of A3Q5 is connected to terminal J on amplifier No. 3. It controls the action of transistor (A6Q1) and turns this transistor ON. This effectively ties the emitter of A6Q2 to the -10 volt supply causing diode (A6CR2) to conduct, back biasing A6Q2, and effectively grounding the driver amplifier output. The collector of A6Q1 is also connected to the base of A6Q3 which is also turned ON, back biasing A6Q4, and connecting the output of the second driver amplifier to ground.

The lower left hand corner of amplifier board No. 1 contains a slow down network made up of transistor (A4Q1) and associated circuitry. The purpose of this circuit is to ground the input to the error amplifier under red light conditions and also to prevent a large voltage surge when the regulator returns to green light operation. The collector voltage from A3Q5, which grounds the driver amplifier, is also routed to the base of A4Q1 turning it ON. When A4Q1 is turned ON, diodes (A4CR1, A4CR2, A4CR3, A4CR4, and A4CR5) all conduct, effectively grounding the amplifier input.

c. Time Delay. When the overcurrent signal triggered the control circuit, capacitor (A3C2) in the monostable circuit was charged. After two or three seconds, the capacitor charge will bleed off to a point where the multivibrator will reset itself to the ON position. This turns the green light back on and removes the ground from T1 and the driver amplifier. If the overcurrent condition has been removed, the green light operation will continue. If not, the monostable multivibrator will again trip to the OFF position, and the red light sequence will begin again.

d. Overvoltage Protection. Overvoltage is sensed at TP2 which is connected to terminal K on the control circuit board. A positive overvoltage will pass through diode (A3CR3), through zener diode (A3CR4), and through diode (A3CR5) to the base of A3Q1. A negative overvoltage will pass through A3CR2, through the zener, and through diode (A3CR10) to the base of A3Q2. Either of these signals will trigger the monostable multivibrator causing it to switch to the red light condition.

e. To insure that the output of the regulator will not exceed its rated capacity of 1 KVA, there is a steady current limiter on the control circuit board. It uses resistor (R8) (connected between test points (TP1 and TP17) to sense the current. An integrating network, consisting of diodes (A3CR1 and A3CR6), resistors (A3R1 and A3R2), and capacitor (A3C1), limits the output to 9.5 amperes. If the 9.5 ampere limit is exceeded for approximately five seconds, the red light cycle will begin.

3.7 Meter Circuits

a. General. The meter circuits are located on

the meter circuit board (A2). Each meter operates from a bridge type rectifier circuit.

b. Voltmeter Circuit. The voltmeter bridge rectifier receives its input from the INPUT VOLTS pushbutton. In the NORMAL position, this switch connects the input of the bridge circuit across test points (TP3 and TP4), the output circuit of the Model 760. When the pushbutton is depressed, input to the rectifier bridge is connected across the input to measure input voltage. Output of the rectifier bridge is connected to a filter and calibration circuit. Potentiometer (A2R10) is adjusted to calibrate the meter to 90 volts with the input button depressed and 90 volts applied to the input of the regulator. Potentiometer (A2R6) is adjusted to calibrate the voltmeter at 135 volts with the input button depressed and 135 volts applied to the regulator.

c. Ammeter Circuit. Input to the ammeter circuit bridge rectifier is obtained from a pair of shunt resistors (R3 and R4) connected in the output circuit. Output of the rectifier bridge is connected to a filter and calibrate circuit. Potentiometer (A2R3) is adjusted to calibrate the ammeter.

SECTION 4
RECALIBRATION

4.1 Recommended Test Equipment

When recalibrating the Model 760 at periodic recalibration intervals or after repairs have been made, the following test instruments or their equivalent are recommended:

Oscilloscope	Tektronix Model 502
Distortion Analyzer	Hewlett-Packard Model 330B
Attenuator Set	Hewlett-Packard Model 350B
Oscillator	Hewlett-Packard Model 200CD
AC Voltmeter	John Fluke Model 803
Multimeter	Triplett Model 630NA
Variac 2 KVA	

CAUTION

It is necessary to perform a phasing check if the transformer is changed. If the unit is turned on and the phasing is incorrect, serious damage to the heatsink assemblies will occur. If heatsinks are operated while removed from the regulator chassis, an auxiliary flow of cooling air must be provided. If the regulator breaks into oscillation, immediately turn the regulator off. Recheck the amplifier gain.

4.2 Power Supply Tests

a. Remove the top and bottom covers, all plug-in boards, and the heatsink assembly. Plug the regulator into a source of 115 VAC and turn the front panel off-on switch ON. Connect the scope return to Pin E on A9 (figure 31) and measure the PS2 voltages as shown below.

Pin C	- 10 V.	.01 V. ripple
J	+ 10 V.	.01 V. ripple
A	- 15 V.	.6 V. ripple
K	+ 15 V.	.6 V. ripple

b. Connect the scope return to Pin A on A10 (figure 32) and measure the PS3 voltages as shown below.

Pin B	+ 12 V.	.2 V. ripple
C	- 12 V.	.2 V. ripple

c. Connect the scope return to Pin N on A10 (figure 32) and measure the PS3 voltages as shown below.

Pin M	+ 12 V.	.2 V. ripple
L	- 12 V.	.2 V. ripple

d. Connect the scope return to TP17 (figure 21) and measure the output voltage of PS1. Voltage across C1 should be -45 volts. Voltage across C2 should be +45 volts.

4.3 Phasing Check

WARNING

It is necessary to perform a phasing check if the transformer is changed. If the unit is turned ON and the phasing is incorrect, serious damage to the heatsink assembly will occur.

a. With the regulator turned OFF, connect TP1 to TP2 with a clip lead. Connect the return lead of the dual channel scope to TP1. Connect one scope input to TP3. Connect the other scope to Pin 10 of T1 (electrically located across R1 from TP2). This serves as a reference voltage.

b. Turn regulator ON. TP3 should be approximately 375 VAC peak-to-peak. Pin 1 of P400 should be approximately 20 VAC peak-to-peak in-phase with TP3.

c. Remove the scope input from Pin 1 of plug and connect it to Pin L of XA7 (figure 14). Pin L should be approximately 70 VAC in-phase with TP3. Turn regulator OFF.

4.4 Voltmeter Calibration

Plug the regulator into a variac and plug the variac into a source of 115 volts AC. Turn the regulator and variac ON. Monitor the output of the variac. Adjust the variac output for 90 volts. Depress the input read button. Then adjust potentiometer (A2R10) until the front panel voltmeter indicates 90 volts. Adjust the variac to 135 volts. Depress the input volts pushbutton and adjust potentiometer (A2R6) until the front panel voltmeter reads 135 volts. Recheck the 90 volt setting as above.

4.5 Ammeter Calibration

Connect a load of approximately .8 KVA to the output of a regulator through an AC ammeter. Turn on the regulator and adjust potentiometer (A2R3) until the calibration of the front panel ammeter corresponds to the reading of the AC ammeter.

4.6 Error Amplifier

a. Amplifier #1 Circuit Board (A4).

(1) With the regulator turned OFF and all plug-in boards and heatsinks removed, unsolder the wires of Pins A and L on XA4. Connect TP1, TP2 and the scope return to chassis ground. Plug the amplifier #1 circuit board (A4) into XA4. Connect the output of a Hewlett-Packard 200CD oscillator to the input of a Hewlett-Packard 350B attenuator set. Connect one input of a dual trace scope to the input of the attenuator set. Connect the low side of the output of the attenuator set to TP4. Connect the high side of the attenuator set to the summing junction (Pin E of XA4). Set the oscillator output for 3 volts AC peak-to-peak 60 cycles per second. Connect the seconds scope input to calibration point 1 (CP1). See figure 26.

NOTE

It is advisable to connect all trim components with clip leads until the entire calibration procedure is completed on a single board since some interaction is present.

(2) Adjust the attenuator set until the waveform at CP1 is no longer clipped. Vary the frequency of the oscillator either side of 60 cycles per second. Trim resistor (A4R15) until peak amplitude occurs at 60 cycles per second.

(3) With the scope connected to CP1, adjust the attenuator set to 18 to 20 db. Trim resistor (A4R20) for equal clipping.

(4) Connect the second scope input to CP2. Trim resistor (A4R31) for maximum amplitude at 60 cycles per second.

(5) Adjust the 350B attenuator set to about 33 db and trim resistor (A4R22) for equal clipping. It may be necessary to vary the amplitude of the oscillator signal to clearly determine if the clipping is equal.

(6) Adjust the attenuator set to 45 db with the output of the oscillator at 3 volts AC peak-to-peak 60 cycles per second. Trim resistor (A4R27) for 45 db ± .5 db gain.

NOTE

Set both scope channels for equal amplification and observe that the waveforms are of equal amplitude. The waveform at CP2 should peak in amplitude at 60 cycles per second and be in phase with the input signal at the summing junction, Pin E of XA4.

(7) Since there is some interaction, recheck the number 1 amplifier trims and adjust, if necessary. When the final trim values have been determined, they may be soldered in place. Do not resolder the wires removed from Pins A and L.

b. Amplifier #2 Circuit Board (A5).

(1) Turn the regulator OFF. Plug in the circuit board amplifier #2 (A5) and connect the second scope input to CP3. Turn the regulator ON and adjust the attenuator set to 60 db. Adjust potentiometer (A5R4) for equal clipping.

(2) Adjust the attenuator set to 70 db. Trim resistor (A5R2) for equal amplitude on both scope traces.

c. Amplifier #3 Circuit Board (A6).

(1) Turn the regulator OFF. Remove the #1 amplifier board (A4) and insert the #3 amplifier board (A6). Connect the high side of the attenuator set to the negative end of a 100 mfd 6 volt capacitor. Connect the positive side of the capacitor to CP3 (figure 27). (This capacitor is not supplied with the regulator.) Turn the regulator ON. Adjust the attenuator set to 0 db. Monitor the output of the oscillator for 3 volts AC peak-to-peak signal. Connect the second scope input to the junction of resistors (A6R9 and A6R10). See figure 28. Increase the output of the oscillator until the waveform starts to clip. Again adjust potentiometer (A5R4) until clipping is equal, top and bottom.

(2) Return the oscillator output to 3 volts AC. Touch the second scope input to the scope return to establish a reference line in the scope. (Center this line on the scope for reference.) Now connect the second scope input to the emitter of transistor (A6Q2, figure 28). The resulting waveform should be as shown in figure 9.

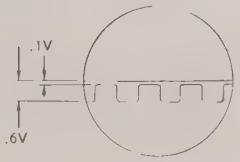


Figure 9. Waveform - Emitter, A6Q2

(3) Connect the second scope input to the emitter of transistor (A6Q4, figure 28). The waveform should be as shown in figure 10.

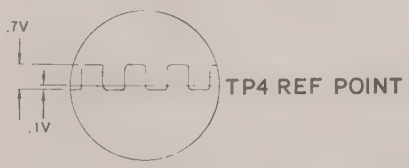


Figure 10. Waveform - Emitter, A6Q4

(4) Connect the scope return to CP10. Establish a reference line on the scope. Connect the scope input to CP9. Waveform should be as shown in figure 11.

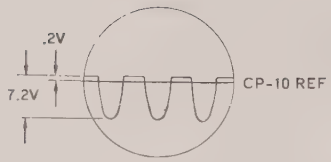


Figure 11. Waveform - CP9

(5) Using the same scope reference line, connect the scope input to CP12. Waveform should be as shown in figure 12.

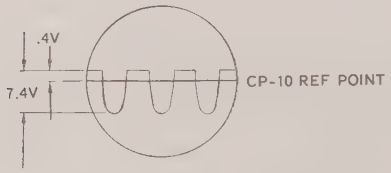


Figure 12. Waveform - CP12

(6) Connect the scope return to the -15 volt point (figure 28). Establish a reference line on the scope. Connect the scope input to the base of transistor (A6Q5). The waveform should be as shown in figure 13.

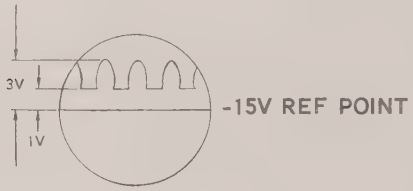


Figure 13. Waveform - Base, A6Q5

(7) Connect the scope return to CP5. Establish a reference line on the scope. Connect the scope input to CP8. The waveform should be as shown in figure 14.

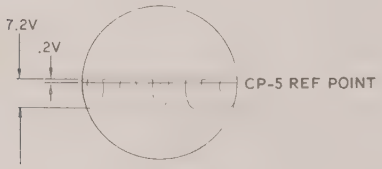


Figure 14. Waveform - CP8

(8) Connect the scope return to CP5. Establish a reference line on the scope. Connect the scope input to CP6. Waveform should be as shown in figure 15.

(9) This concludes the calibration of error amplifier boards 1, 2, and 3. Remove the test equipment, solder all trim components, and reconnect all wires removed during the calibration procedure.

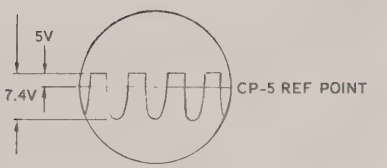


Figure 15. Waveform - CP6

4.7 Control Board

a. With regulator turned OFF, remove all plug-in boards. Plug in the control board, turn the regulator ON. The red indicator on the front panel should light immediately. In approximately 5 seconds, the green indicator should light and the red indicator extinguish.

b. Connect the scope return to TP4. Establish a reference line on the scope. Connect the scope input to Pin E of XA3. Scope should indicate a DC level of -.5 volts.

c. Connect CP13 to CP14 with a clip lead (figure 25). The voltage at Pin E of XA3 should now indicate a voltage of -8.5 volts.

d. Connect the scope return to the +15 volt point (figure 25). Establish a reference line on the scope. Connect the scope input to the junction of resistors A3R27 and A3R33). (This is the base of transistor A3Q10, figure 25.) Remove the clip lead between CP13 and CP14. Note the voltage level on the scope. Reconnect the clip lead between CP13 and CP14. The voltage level should drop 1 volt.

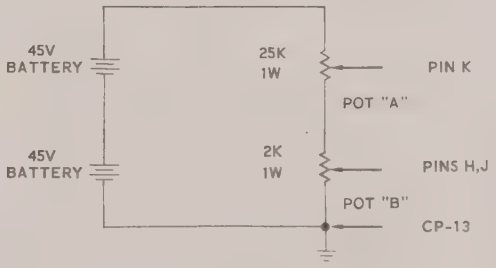


Figure 16. Red and Green Light Test Circuit

e. Turn the regulator OFF. Connect TP1 to TP2 with clip lead. Connect the test set as shown in figure 16. Remove the wire from Pin K of XA3 and connect the arm of potentiometer A to Pin K. Connect the ground point of the test set to CP13. Turn the regulator ON. Vary potentiometer A. The regulator should go on to red light at about 56 volts input to Pin K. Reverse the battery polarity and repeat.

f. Turn the regulator OFF. Resolder the wire to Pin K of XA3. Remove the jumper wire between

Pins H and J and the wire going to these pins on XA3. Connect the arm of pot B to Pin H. Turn the regulator ON. Vary pot B and check that the unit goes into red light at 3.2 volts. Reverse the battery polarity and repeat.

g. With the regulator OFF, connect the arm of pot B to Pin J. Turn the regulator ON and check that the unit goes into red light at +1 volt. Turn the regulator OFF and resolder the jumper between Pins H and J and the wire going to these pins.

h. This completes the calibration of the control circuit board. Remove all test equipment and resolder all the wires disconnected during the calibration procedure.

4.8 Reference

a. Reference #1 Circuit Board (A7).

(1) With the regulator turned OFF, remove all plug-in boards. Insert the reference #1 board (A7) and adjust potentiometer (A7R2) to the center of its travel. Since this is a 20 turn potentiometer, screw the arm to one end and back it off ten turns. Unsolder the wire from Pin H of XA7. Use the oscillator to insert a 1 volt AC peak-to-peak signal into Pin N of XA7. Connect the scope return to TP4 and the scope input to CP15 (figure 29). Vary the frequency of the oscillator and trim the reference #1 circuit board until peak amplitude occurs at 41.7 cycles per second. Trim the reference #1 board by changing the values of capacitors (A7C4, C5, and C6, figure 29).

(2) Check the oscillator for 1 volt AC peak-to-peak input to the reference #1. Measure the output voltage and trim resistor (A7R14) until the gain of the reference #1 circuit board is 5.8 ± 0.1.

b. Reference #2 Circuit Board (A8).

(1) With the regulator OFF, remove the reference #1 circuit board (A7) and insert the reference #2 circuit board (A8). Inject a 1 volt peak-to-peak signal from the oscillator into Pin H of XA8. Connect the scope return to TP4. Connect the scope input to the connection shown in figure 30. Turn regulator ON and vary the frequency of the oscillator. Trim the board with the frequency adjust capacitors until the peak amplitude occurs at 73 cycles per second. The frequency adjust capacitors are A8C1, A8C2, and A8C3 as shown in figure 30.

(2) Compare the input from the oscillator to the output at CP16 (figure 30) and trim resistor (A8R6) until the gain of reference #2 circuit board is 7 ± 0.1.

(3) With the regulator OFF, insert the reference #1 circuit board (A7). Use the oscillator to insert a 1 volt AC peak-to-peak signal at Pin N of XA7. Vary the frequency of the oscillator. The scope connected to CP16 should now indicate a dip at 60 cycles per second.

(4) Solder all trim values in place and reconnect the wire to Pin H of XA7.

(5) With both reference boards A7 and A8 in position, connect the scope return to TP4. Connect the scope input to Pin H of XA7. Turn the regulator ON. Voltage at Pin H should be a square wave with an amplitude of 3.5 volts ± 1/2 volt.

(6) Connect the scope input to CP16. The waveform at this point should be a sine wave with an amplitude of 9 volts ± 1 volt. The regulator output adjust on the front panel should vary the voltage between 8 and 10 volts AC.

(7) Connect the low side of a Hewlett-Packard 330B distortion analyzer to TP4. Connect the high side to CP16 of circuit board (A8). Distortion should not exceed .16%.

NOTE

If the 3.5 volts square wave amplitude is high, the distortion may also be high. In this event, change diode (A7CR3) to reduce the amplitude of the square wave.

4.9 Quadrature Test

With the regulator OFF, plug in all circuit boards except the control board (A3) and the heatsink (A11). Connect the scope return to TP1, connect TP1 and TP2 with a clip lead. Connect the scope input to the summing junction (Pin E on XA4). Plug the regulator into a variac. Turn the regulator ON and adjust the variac for the minimum amplitude on the scope trace. This should occur with approximately 105 to 110 volts from the variac. Adjust potentiometer (A7R2, figure 29) and readjust the variac for a minimum amplitude of the scope trace. Continue adjusting the potentiometer and variac until the waveform is less than .2 volts peak-to-peak (figure 17).

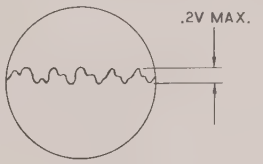


Figure 17. Waveform - Summing Junction

NOTE

The waveform in figure 17 is the harmonic residual when the voltage difference at the summing junction is 0. If the waveform is in excess of .2 volts, one cause may be excessive gain in the reference circuit boards. Reducing the gain by trimming resistor (A8R3, figure 30) will cause a reduction in harmonic residual, but will also reduce the capability of the amplifier to regulate at low line voltage (95 volts) and at high line voltage (135 volts).

4.10 Heatsinks

a. General. The following is the procedure for checking the heatsinks for bad components before installing heatsinks in the regulator. This check can be performed with an ohmmeter. Since transistor junctions have a low resistance in one direction and a high resistance in the other, an ohmmeter can be used to determine if the junction is operable. If the ohmmeter gives a low reading in one direction and a high reading when the leads are reversed, the junction is in operating condition. If the ohmmeter gives a low reading in both directions or indicates an open in both directions, the junction is probably bad.

b. Preliminary Check. With clip leads, tie Pin F to Pin G on the heatsink. Also tie Pin E to Pin C on the heatsink. Make the following checks:

(1) Use the ohmmeter to check continuity between Pin 4 and Pin 6 of A11P1. Reverse the ohmmeter leads and repeat. A very low resistance in both directions indicates that sections 1 and 2 of the heatsink assembly are shorted. The low resistance should be less than 10 ohms and the high resistance more than 50 ohms.

(2) Use an ohmmeter to check the continuity between Pin 6 and Pin 7 of A11P1. Reverse the ohmmeter leads and repeat. A low resistance reading in both directions indicates a short between sections 3 and 4 of the heatsink assembly. The low resistance should be less than 10 ohms and the high resistance more than 50 ohms.

NOTE

If neither section is shorted in the above tests, skip the next two sections regarding repair of heatsink assembly.

c. Repair of Heatsink Sections 1 and 2.

(1) Remove all insulators holding heatsinks 1 and 2.

(2) Check transistor (A11Q1) in heatsink 1. Remove the emitter wire only.

(3) Check the transistor using the ohmmeter. A check from emitter to collector and from collector to emitter should give a relatively high resistance. Checking from base to emitter, collector to base and emitter to base should give a low resistance in one direction, and a high resistance in the other. If OK, replace wires.

(4) Check transistor (A11Q10). Remove the emitter and base wires. Repeat step 3.

(5) Check transistor (A11Q6). Remove the emitter and base wires and repeat step 3.

(6) Check transistor (A11Q14). Remove the emitter and base wires and repeat step 3.

(7) Replace all defective transistors. Make sure all wires are securely soldered in place on heatsink 1.

(8) Check transistor (A11Q13) on heatsink 2. Remove emitter and base wires and repeat step 3.

(9) Check diode (A11CR3). Remove the wire and check continuity in both directions. Ohmmeter should indicate a low resistance in one direction only. If diode checks OK, resolder wire.

(10) Check transistor (A11Q5). Remove emitter and base wires and repeat step 3.

(11) Check transistor (A11Q3). Remove emitter and base wires and repeat step 3.

(12) Check transistor (A11Q9). Remove emitter and base wires and repeat step 3.

(13) Replace defective transistors. Check all solder joints on heatsink 2.

(14) Use the ohmmeter to check for electrical isolation of transistor (A11Q1) from the heatsink.

(15) Replace all insulators holding heatsink 1 to top plate and heatsink 1 to 2. This completes repair of heatsink sections 1 and 2.

c. Repair of Heatsinks 3 and 4.

(1) Remove all insulators holding heatsinks 3 and 4. Check transistor (A11Q7) on heatsink 2. Remove emitter and base wires and repeat step b. (3) above.

(2) Check diode (A11CR4). Remove wire and use an ohmmeter to check resistance in both directions. Ohmmeter should indicate a low resistance in one direction only. If OK, replace wire.

(3) Check transistors (A11Q11, Q11Q4, and A11Q15). In each instance, remove the base and emitter wires and repeat step b. (3) above.

(4) Replace all defective transistors and check all solder joints on heatsink 3.

(5) Check transistors (A11Q2, A11Q12, and A11Q8) on heatsink 4 by removing emitter and base wires and repeat step b. (3) above.

(6) Replace all defective transistors and check all solder joints on heatsink 4.

(7) Check for electrical isolation of transistor (A11Q2) case from heatsink.

(8) Replace all insulators holding heatsinks 2 to 3 and 3 to 4. These two sections are now ready for final checkout below.

d. Heatsink Check.

WARNING

If heatsink is operated while removed from the regulator chassis, some means of obtaining a continuous air flow must be provided.

(1) Remove all boards from unit.

(2) Remove clip lead (if any) from TP2 to TP1 and connect the scope return to regulator ground TP1.

(3) Install the heatsink assembly in the unit, making sure that the connector plug is firmly in the socket.

(4) With the scope attenuator set at 10 volts per centimeter, DC coupled, connect the scope to terminal E on heatsink top plate (figure 33).

(5) Momentarily turn the regulator ON. The scope should show a 20 volt AC peak-to-peak signal. If the scope trace goes negative, repeat section b. above. If the scope trace goes positive, repeat section c. above. If the unit refuses to turn on with the heatsink assembly connected, repeat both sections and check plug connections at both male and female junctions.

e. Voltage Splitting.

(1) Connect the dual beam scope return to point F on the heatsink (figure 33). Zero both traces to one reference line and set for 10 volts per centimeter, DC coupled. Connect one input to TP9, the other to point E on the heatsink.

(2) Turn the unit ON. The trace connected to Test Point 9 should be 1/2 the value of the other trace.

(3) Check Test Point 10 and Test Point 11 for the same 1/2 value positioning as in steps 1 and 2 above.

(4) If the above three check points do not split properly, check the junction of A11R12 and A11R13. If the voltage at this point does not split, check the wiring. If the voltages at this point do split, check for a faulty transistor (A11Q4) or incorrect wiring.

(5) Connect the scope return to Pin E, one input to Pin D, and the other to Test Point 6 (TP6).

(6) Turn the regulator unit ON. This same pattern should occur as in steps 2 and 3 above. Check Test Point 7 and Test Point 8 for similar patterns.

(7) If all three check points do not split, check the wiring to resistors (A11R8 and A11R9). If the voltage at these two resistors does not split, check the wiring. If the voltages at this point split properly, check for a faulty transistor (A11Q3) or incorrect wiring. This concludes the test for voltage splitting.

f. Current Splitting.

(1) With the regulator unit turned OFF, insert the amplifier 2 and amplifier 3 circuit boards (A5 and A6). With the scope return connected to regulator ground and the scope input on Pin E of the heatsink assembly, set the scope for 10 volts per centimeter, DC coupled.

(2) Turn the regulator unit ON. If the trace goes negative or positive by 40 volts or more, amplifier 3 is defective.

(3) With the scope and sine wave oscillator synchronized to the 60 cycle AC line, connect the low side of the oscillator to the regulator ground (TP1) and the high side to the negative side of a 200 microfarad 6 volt capacitor. Connect the positive side of this capacitor to calibration point 3 (CP3) on amplifier circuit board 2 (figure 27).

(4) Turn the regulator unit ON and adjust the oscillator for 60 volts peak-to-peak sine wave at Pin E on heatsink (A11).

(5) With the regulator OFF, connect the scope return to Pin E on the heatsink assembly. Set the scope input for 0.1 volts per centimeter, DC coupled and connect the inputs to transistor (A11Q6) emitter and transistor (A11Q10) emitter on the heatsink plate. See figure 33. Turn the regulator ON and two identical signals should appear on the scope. See figure 18. Now check the emitter of transistor

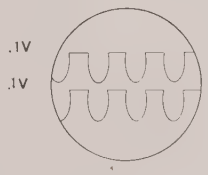


Figure 18

(A11Q14). It should also be the same. If not, remove the heatsink assembly and check emitter and base wires on the transistors in heatsinks 1 and 2. The waves should agree with the figures shown within 10%.

(6) Connect the scope return to F on the heatsink plate and check the current divisions on the emitters of transistors (A11Q8, A11Q12, and A11Q16). If the current division is unequal, check the emitter and base wires to be sure they are not reversed on heatsinks 3 and 4. This concludes the current division test.

4.11 Loop Closing

(1) With the regulator OFF, install all the plug-in boards except the control board.

(2) Connect the scope return to TP1. Adjust the scope for 10 volts per division, connect input to TP2.

(3) Plug the regulator into a variac and adjust the variac for 105 volts AC. Turn the regulator ON.

(4) Adjust the variac for the minimum amplitude quadrature signal. Adjust A7R2 (Ref. 1) for minimum signal. Repeat if necessary to obtain minimum signal. Maximum quadrature shall not exceed 15 volts peak-to-peak.

4.12 Output Range Adjust

(1) Remove the control board (A3). Turn the OUTPUT ADJUST control on the front panel fully clockwise. Adjust potentiometer (A8R9) for 122 volts AC indicated on the front panel voltmeter (figure 30).

(2) Turn the OUTPUT ADJUST control fully counterclockwise. Adjust potentiometer (A8R10) for 108 volts AC indicated on the front panel voltmeter. Repeat these two steps, since there is some interaction between the adjustments.

(3) If the potentiometers (A8R9 and A8R10) do not permit the correct adjustment, change the value of resistor (A8R3) and repeat the above procedure.

4.13 Amplifier Swing

(1) With the regulator OFF, remove the control board (A3). Set the input range switch on the rear panel to the 105-125 volt position.

(2) Adjust the scope for 20 volts AC per division. Connect the scope return to Test Point 1. Connect the scope input lead to Test Point 2.

(3) Plug the regulator into a variac. Turn the regulator ON and swing the variac from 105 volts AC to 125 volts AC. Check to see that the amplifier waveform does not clip or oscillate.

NOTE

If the regulator breaks into oscillation, immediately turn the regulator OFF. Recheck the amplifier gain.

(4) With the regulator OFF, remove the amplifier No. 1 circuit board and install the control board.

(5) Adjust the scope for 10 volts AC per division. Turn the regulator ON. Waveform should be as shown in figures 19 and 20 below in the red light and green light conditions respectively.

Figure 19

Figure 20

SECTION 5
SERVICING

5.1 General

The following tables supply information which will enable the maintenance technician to test individual sections of the Model 760 in order to determine if they are operating properly, and also localize troubles to a particular section of the instrument. This troubleshooting section is to be utilized in conjunction with Section 4 RECALIBRATION. The recommended test equipment for the following tests is itemized in paragraph 4.1 Recommended Test Equipment.

5.2 Test Point and Calibration Point Locations

Listed in Sections 4 and 5, and shown on the schematic diagram, are a number of test and calibration points which are useful to the maintenance technician. These points are identified on the parts illustrations. Table I below lists these points, the figure on which they are identified, and any additional useful information on each point.

5.3 DC Voltage Readings

The DC voltage measured at each Test Point, Calibration Point, and at the connector to each circuit board is given in Table II.

TABLE I

TEST POINT AND CALIBRATION POINT LOCATIONS

Point	Location - Figure No.	Note
TP1	21	Regulator Ground
TP2	21	
TP3	21	Regulator Output
TP4	21	Regulator Return
TP6	33	Collector A11Q6, Emitter A11Q5
TP7	33	Collector A11Q10, Emitter A11Q9
TP8	33	Collector A11Q14, Emitter A11Q13
TP9	33	Collector A11Q8, Emitter A11Q7
TP10	33	Collector A11Q12, Emitter A11Q11
TP11	33	Collector A11Q16, Emitter A11Q15
TP17	21	Common for +45 and -45 supply
Pin E of XA4	26	Summing Junction
CP1	26	
CP2	26	Output of A4
CP3	27	
CP4	27	
CP5	28	
CP6	28	Output of A6
CP7	28	+15 volts from A10-M
CP8	28	
CP9	28	
CP10	28	+45 volts
CP11	28	
CP12	28	Output of A6
CP13	25	Regulator Ground
CP14	25	
CP15	29	Output of A7
CP16	30	Output of A8
+15 volt point	25	
-15 volt point	28	Same as A10-L
Base of A3Q10	25	
Junction A6R9 and A6R10	28	
Emitter of A3Q2	28	
Emitter of A3Q4	28	
Base of A3Q5	28	
Scope Connection A8	30	
Junction of A11R6 and A11R16	33	Emitter A11Q2, Base A11Q8, A11Q12, A11Q16
Junction of A11R8 and A11R9	33	Base of A11Q3
Junction of A11R12 and A11R13	33	Base of A11Q4
Emitter of A11Q6	33	
Emitter of A11Q8	33	
Emitter of A11Q10	33	
Emitter of A11Q12	33	
Emitter of A11Q14	33	
Emitter of A11Q16	33	

TABLE II

DC VOLTAGE READINGS - MODEL 760

TERMINAL (4)	AMP #1 A4	AMP #2 A5	AMP #3 A6	CONTROL A3	REF #1 A7	REF #2 A8	METER A2	PS #3 A10	PS #2 A9	HEATSINK A11 (3)	CALIBRATION POINTS	TEST POINTS
A or 1	+.022	----	+12	-7.7	-10	-10	+.45	+48	-15	-.19	-3.6	----
B or 2	-10	-10	-.19	-14	0	0	+.12	+60	-15	-12	-4.5	----
C or 3	-.43	----	+.03	-10	----	+.02	+.12	+37	-10	+12	+7.5	----
D or 4	0	+.035	-12	-14	----	-3.0	+.48	+48	0	-50	-2.3	REF
E or 5	+.021	----	-10	-.43	----	-3.0	+42	+48	0	----	+.13	----
F or 6	0	----	0	-.27	----	----	+42	+.002	0	0	-.05	-25
G or 7								+15	+.09	+50	+12	-25
H or 8	0	----	-.04	0	-3.1	-2.8	+.08	-15	+.1	+60	-.2	-25
I or 9										+36	+48	+25
J or 10	0	-.04	-.43	0	----	-2.6	REF	+.02	+10	+50	+48	+25
K or 11	0	----	+10	+.03	----	----		+.02	+15	+.03	+60	+25
L or 12	----	----	----	-15	-.025	----		-12	+15	----	+48	----
M or 13	----	----	----	----	+10	----		+12			-.27	----
N or 14	0	0	+36	+15	-3.1	-2.4		----			-.003	----
O or 15											-2.8	----
P or 16	-4.5	-4.5	+48	+10	-2.8	0					+.019	----
Q or 17												----
R or 18	+10	+10	+60	0	-2.9	+10						----
S or 19	----	-.04	+48	-15	-2.9	-2.7						----

NOTE:

1. The DC voltages were measured under normal operating conditions with no load on the regulator. Applied line voltage was 125 volts. Output of the regulator was set at 115 volts.

2. Reference point for all readings was TP4. All readings are given in volts.

3. Heatsink voltages are difficult to measure at the connector (P1). Refer to Figure 33 for the connection of P1 to the A11 terminal strip.

4. All connectors have lettered pins except for the heatsink (A11), the calibration points, and the test points which are numbered.

5. [redacted] Pin does not exist on that connector.

6. ---- Not applicable.

SECTION 6
LIST OF REPLACEABLE PARTS

6.1 Identification of Sub-Assemblies

Parts in this list are called out in order of the sub-assembly on which they are mounted. The sub-assemblies contained in this parts list are indicated as follows:

Diode Mounting Plate	Printed Circuit Board A1
Meter	Printed Circuit Board A2
Control	Printed Circuit Board A3
Amplifier No. 1	Printed Circuit Board A4
Amplifier No. 2	Printed Circuit Board A5
Amplifier No. 3	Printed Circuit Board A6
Reference No. 1	Printed Circuit Board A7
Reference No. 2	Printed Circuit Board A8
Power Supply No. 2	Printed Circuit Board A9
Power Supply No. 3	Printed Circuit Board A10
Heatsink	Printed Circuit Board A11

Components not on a special printed circuit board follow the last sub-assembly.

6.2 Parts Description

A complete description, the Beckman part number, and the original manufacturer and his part number are supplied for each replaceable part. The original manufacturer's name is supplied in coded form. Refer to the table in Section 6 of the Model 700 manual for the manufacturer's name and address.

When ordering parts, give the complete description and all part numbers as shown in the parts list. The model number and serial number of the equipment should also be supplied.

It is strongly recommended that the entire printed-circuit board assembly be replaced, rather than a component of it, especially in the case of those assemblies that include factory-selected values.

6.3 Parts Illustrations

The location of each part in the illustrations in the manual is simplified by the use of the right hand column on the parts pages titled LOCATION - FIGURE NO. The figure number of the illustration in which this part is shown will appear in this column.

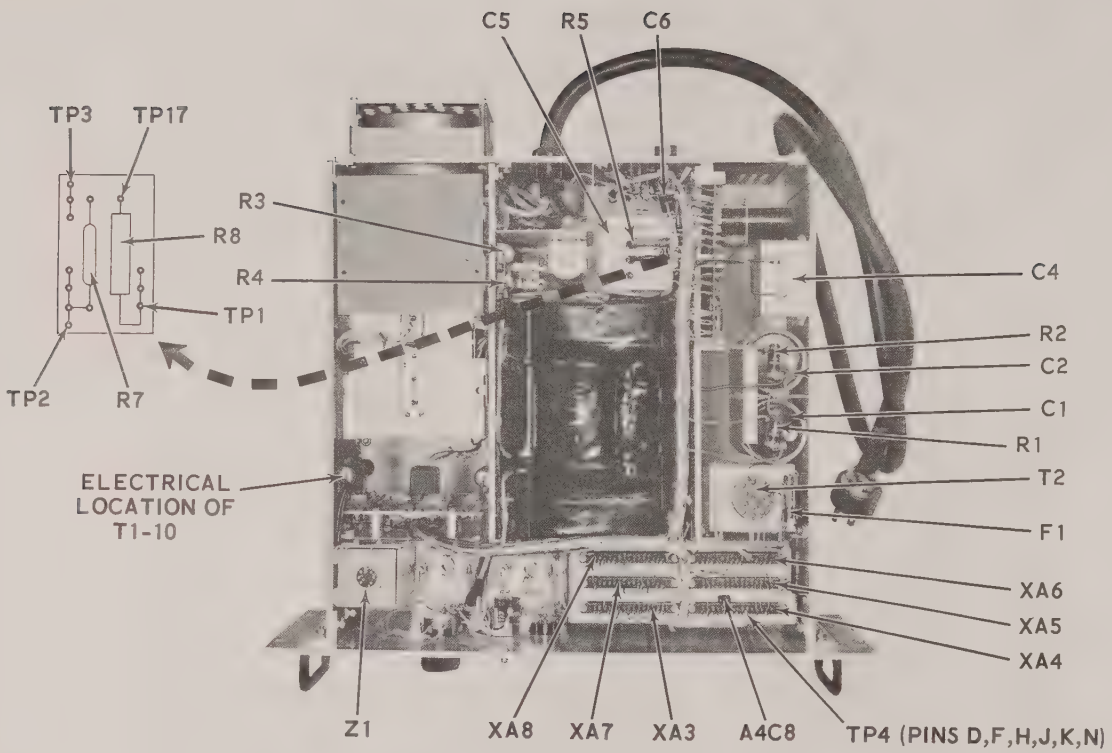


Figure 21. Bottom View - Model 760

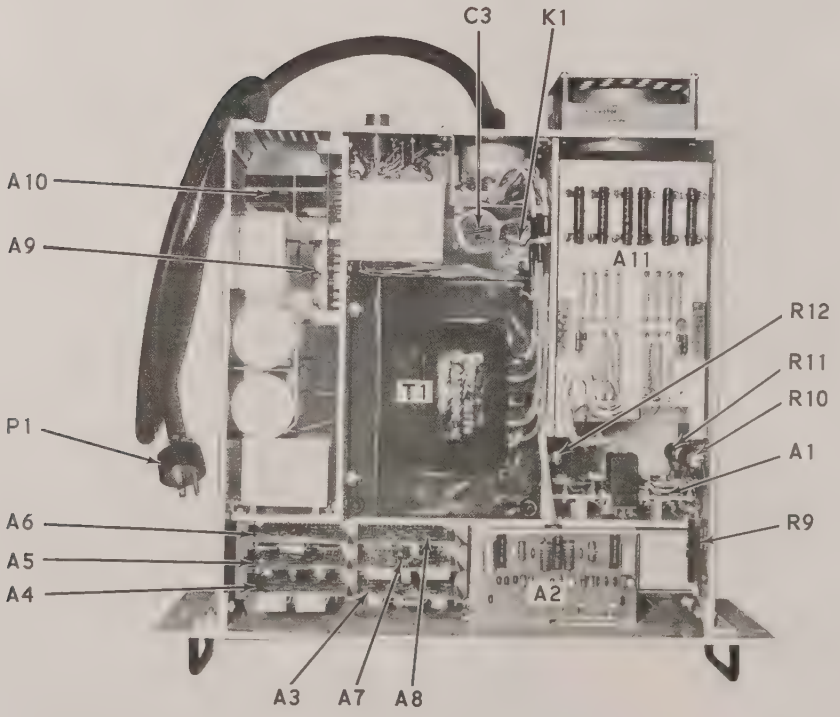


Figure 22. Top View - Model 760

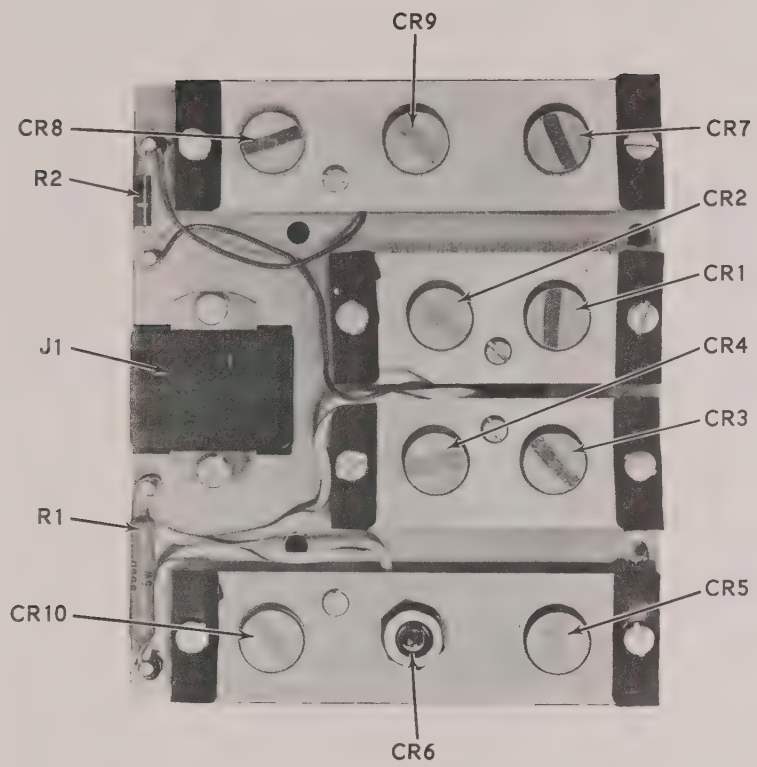


Figure 23. Diode Mounting Plate Assembly (A1) - Drawing 855-418925

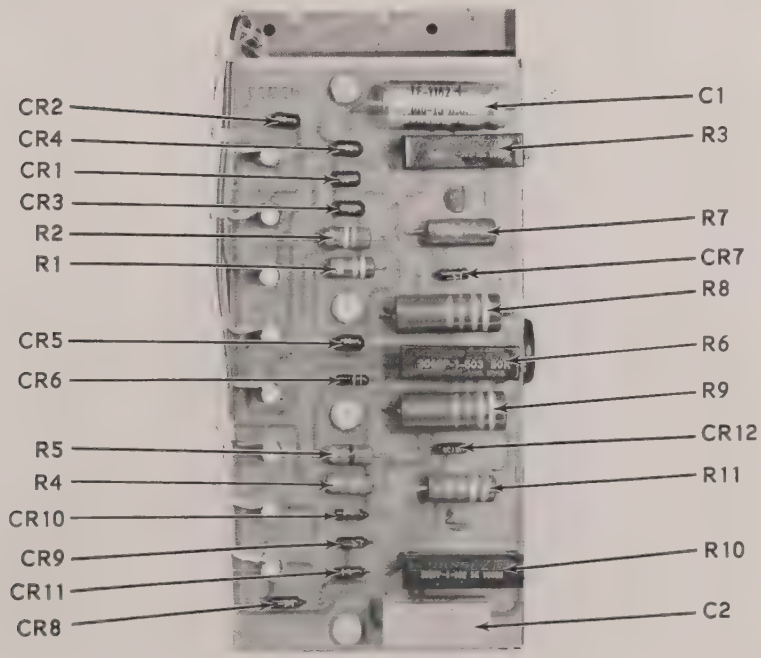
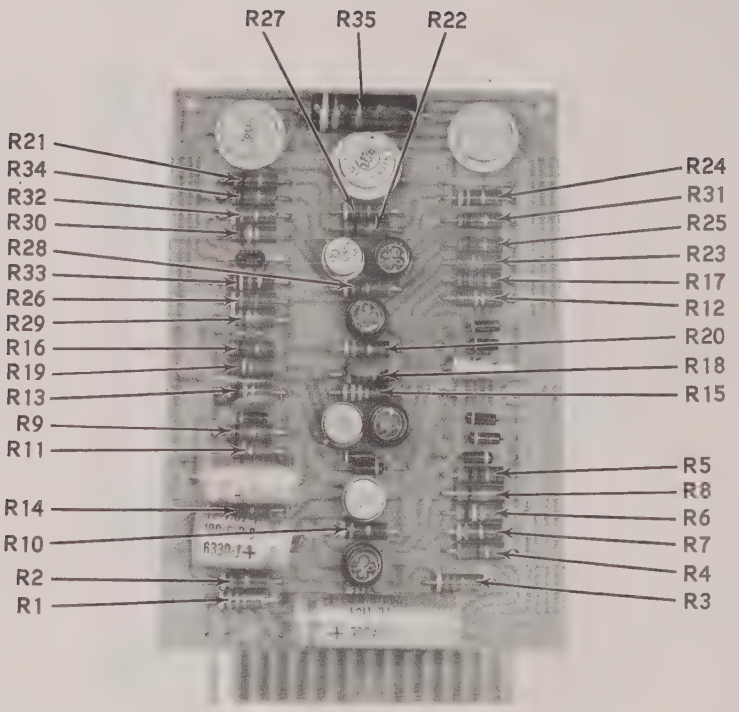


Figure 24. Meter Board Assembly (A2) - Drawing 855-418924



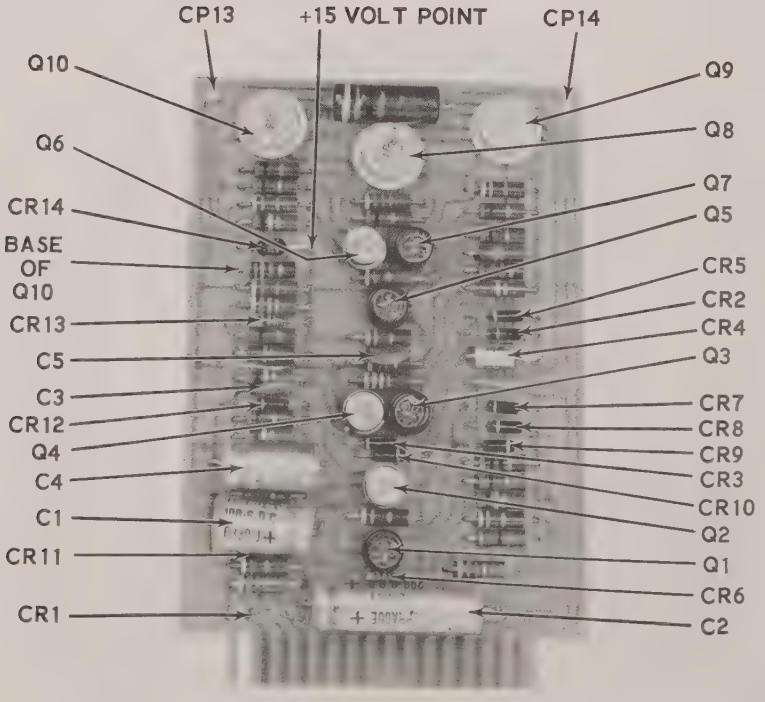


Figure 25. Control Board Assembly (A3) - Drawing 887-419204

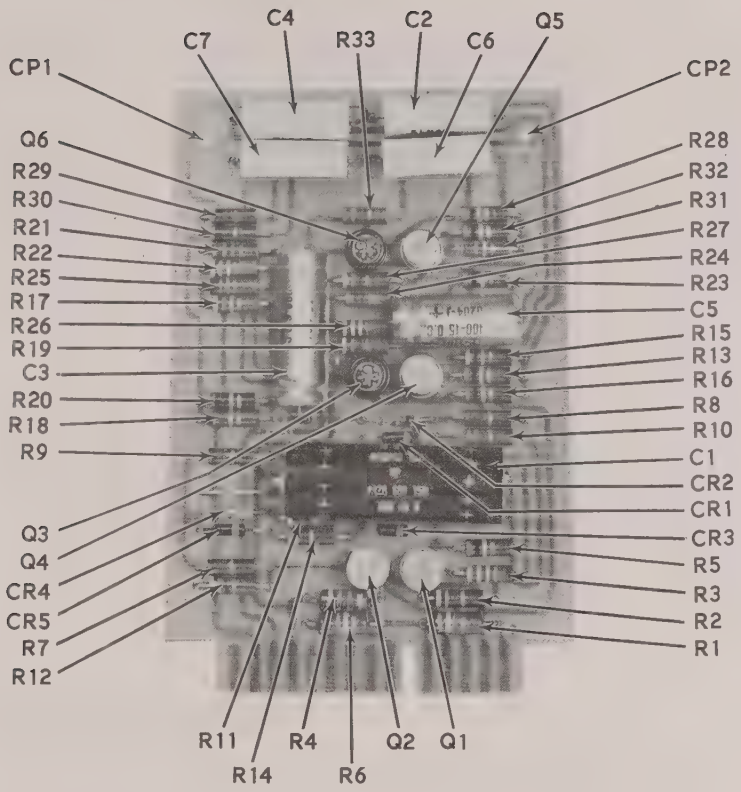


Figure 26. Amplifier #1 Board Assembly (A4) - Drawing 887-419205

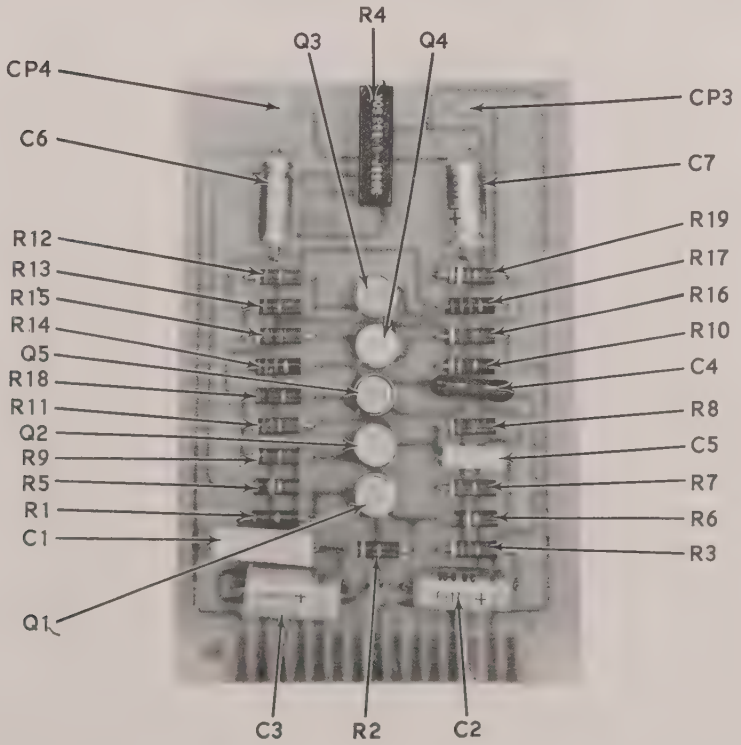


Figure 27. Amplifier #2 Board Assembly (A5) - Drawing 887-419206

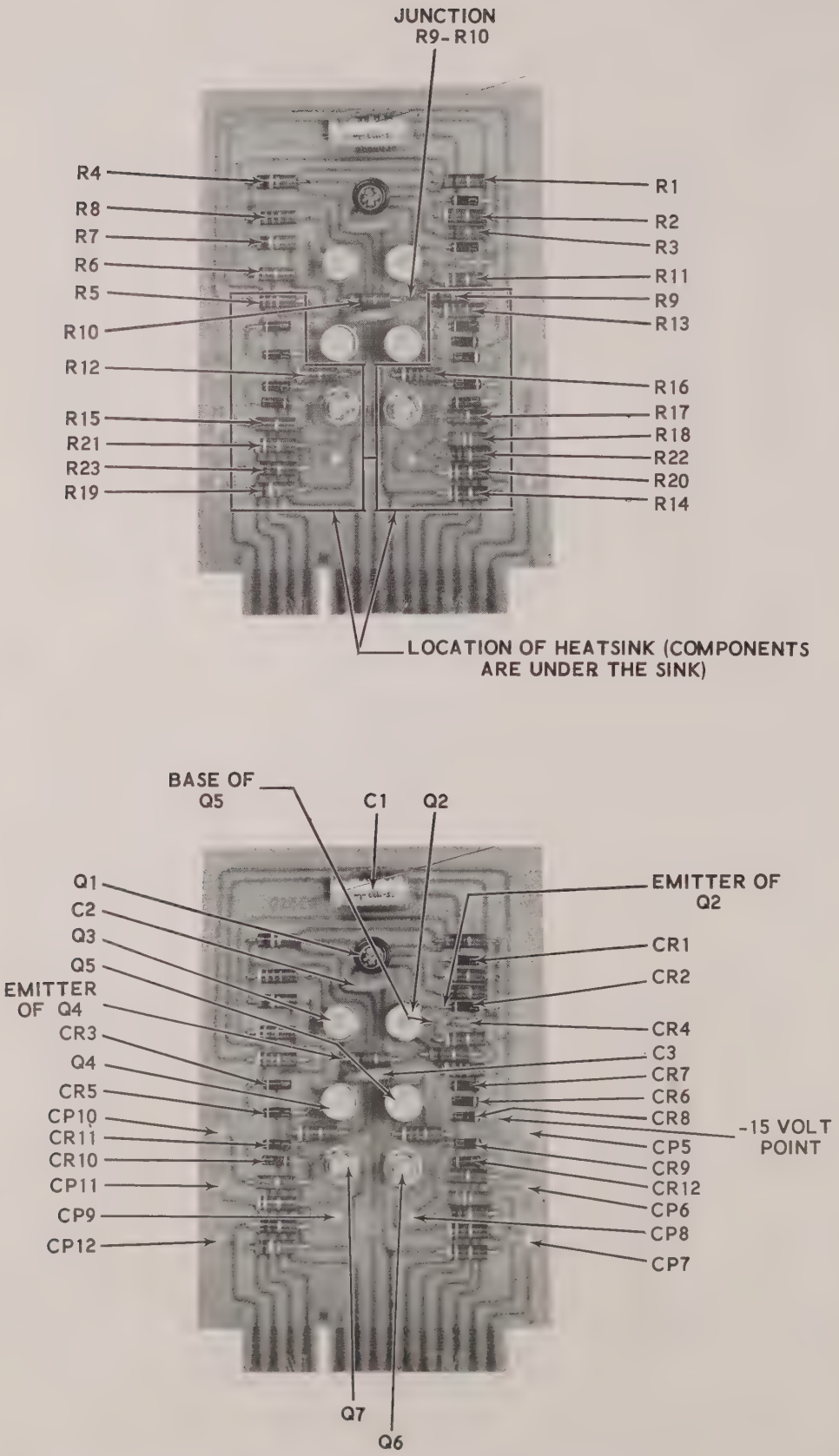


Figure 28. Amplifier #3 Board Assembly (A6) - Drawing 887-419207

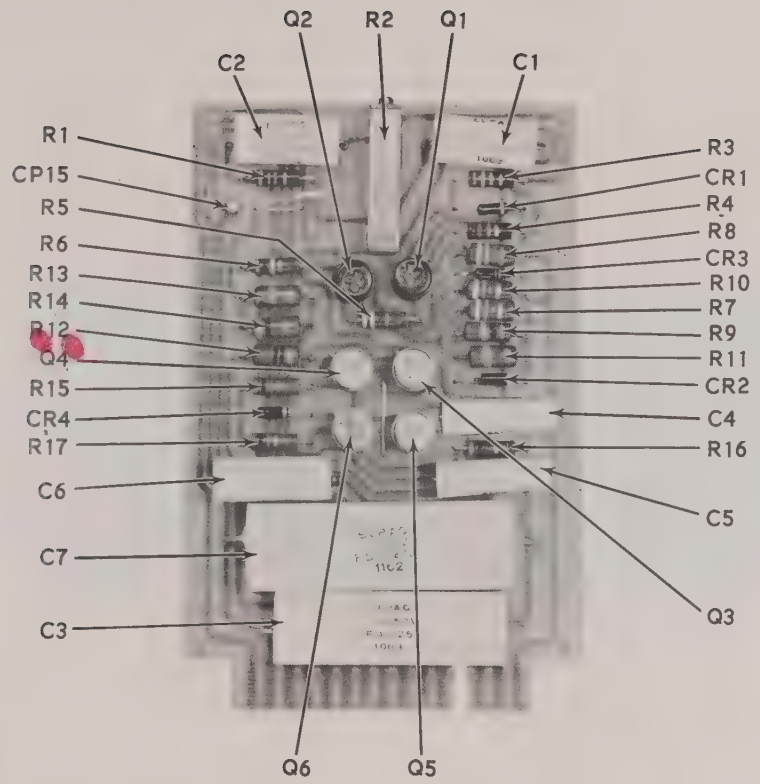


Figure 29. Reference #1 Board Assembly (A7) - Drawing 887-419208

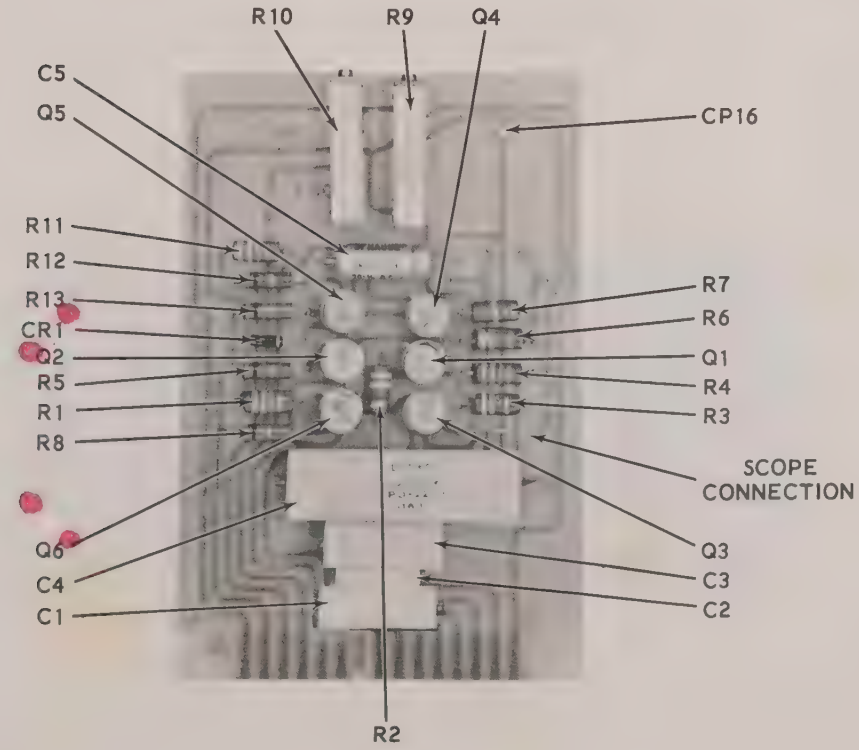


Figure 30. Reference #2 Board Assembly (A8) - Drawing 887-419209

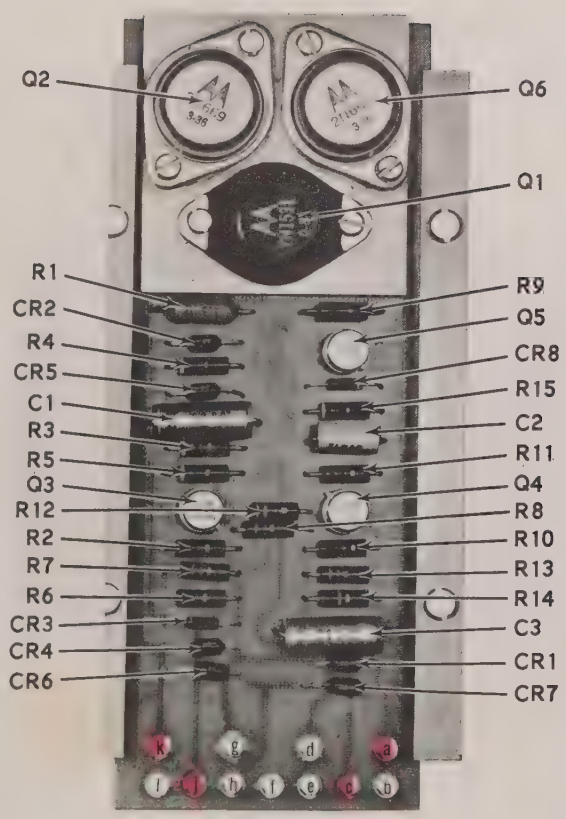


Figure 31. Power Supply #2 Board Assembly (A9) - Drawing 855-419211

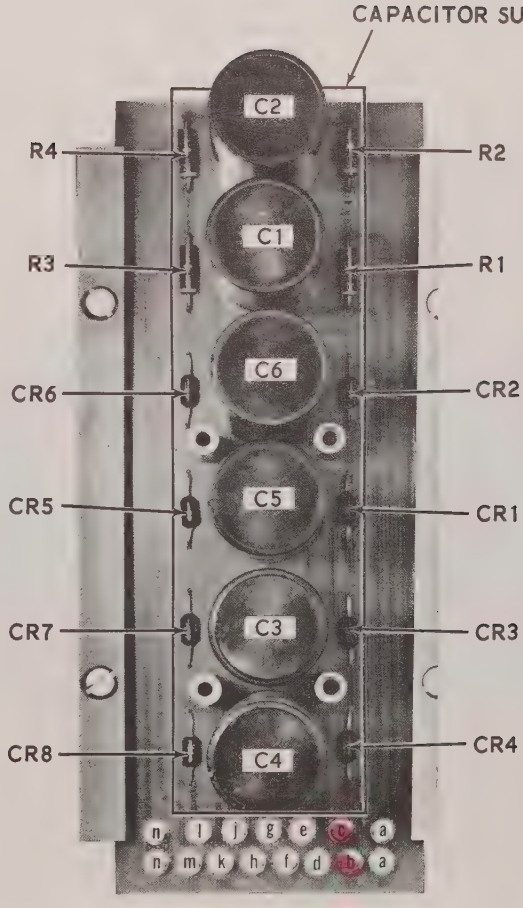


Figure 32. Power Supply #3 Board Assembly (A10) - Drawing 855-419210

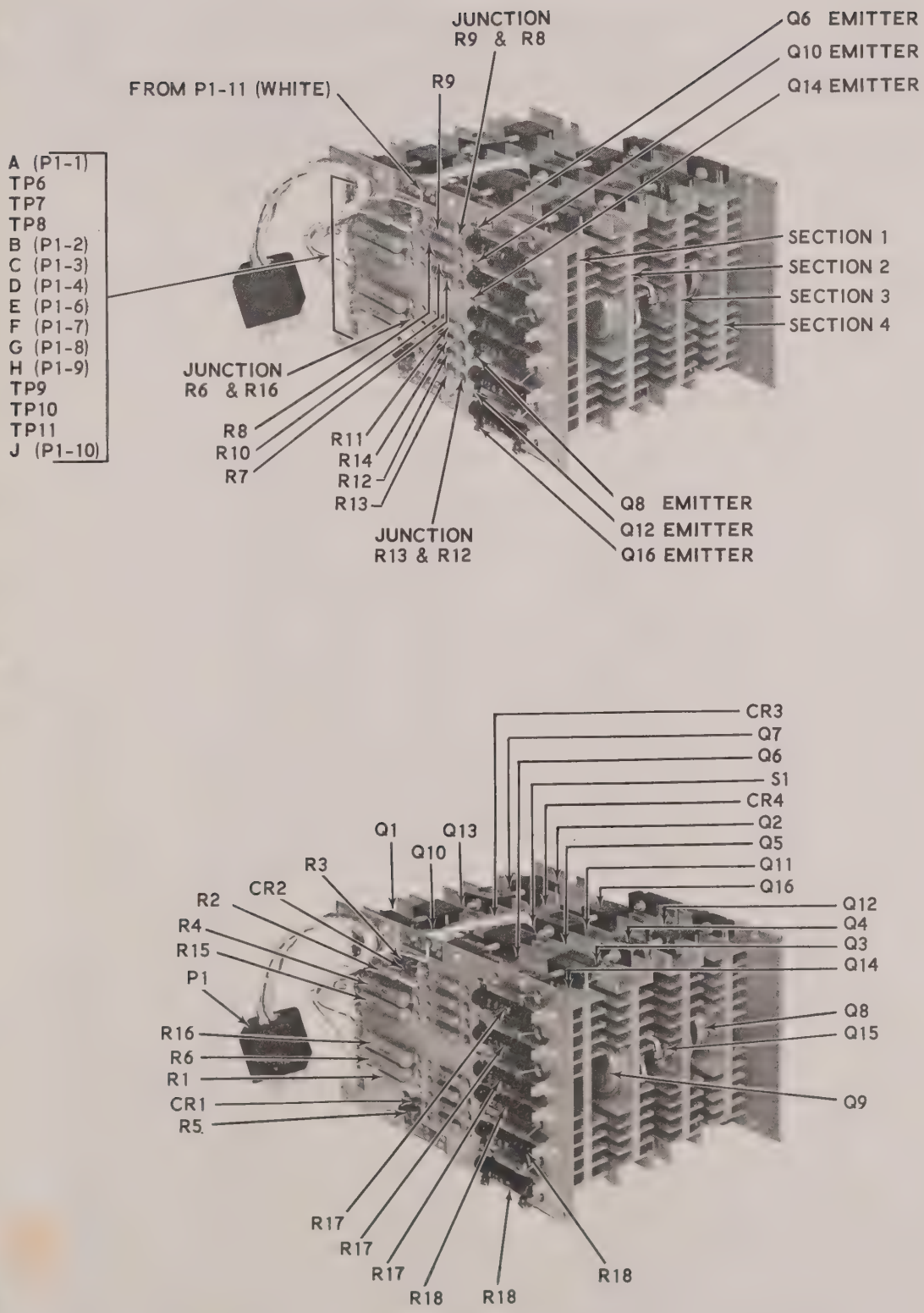


Figure 33. Heatsink Assembly (A11) - Drawing 855-419220

LIST OF REPLACEABLE PARTS

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A1	DIODE MOUNTING PLATE ASSEMBLY	855-418925	DI	855-418925	22,23
CR1	Rectifier, Silicon, Type MR324R	755-829376	AL	MR324R	23
CR2	Rectifier, Silicon, 200 PIV, 18 Amps	755-829375	AL	MR324	23
CR3	Rectifier, Silicon, Type MR324R	755-829376	AL	MR324R	23
CR4	Rectifier, Silicon, 200 PIV, 18 Amps	755-829395	AL	MR324	23
CR5	Rectifier, Silicon, 200 PIV, 18 Amps	755-829395	AL	MR324	23
CR6	Rectifier, Silicon, Controlled, 100 PRV, 16A IDC	755-829917	CW	2N1844	23
CR7	Rectifier, Silicon, Type MR324R	755-829376	AL	MR324R	23
CR8	Rectifier, Silicon, Type MR324R	755-829376	AL	MR324R	23
CR9	Rectifier, Silicon, 200 PIV, 18 Amps	755-829375	AL	MR324	23
CR10	Rectifier, Silicon, 200 PIV, 18 Amps	755-829375	AL	MR324	23
J1	Socket, 12 Pin, w/Angle Brackets	672-818767	BW	261-12-12-010	23
R1	Resistor, F. W. W., 500 Ohms, 5 Watts	604-829916	CM	5X500	23
R2	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	23
A2	METER BOARD ASSEMBLY	855-418924	DI	855-418924	22,24
C1	Capacitor, F. Elect., 100mf, 15 Volts	631-802909	NN	TE1162	24
C2	Capacitor, F. Mylar, .47 mf, 100 Volts, 5%	651-834272	CU	ZD1P474J	24
CR1	Diode, Silicon, 600 PIV, 1 Amp, Special	755-416842	DI	755-416842	24
CR2	Diode, Silicon, 600 PIV, 1 Amp, Special	755-416842	DI	755-416842	24
CR3	Diode, Silicon, 600 PIV, 1 Amp, Special	755-416842	DI	755-416842	24
CR4	Diode, Silicon, 600 PIV, 1 Amp, Special	755-416842	DI	755-416842	24
CR5	Diode, Silicon, 600 PIV, 1 Amp, Special	755-416842	DI	755-416842	24
CR6	Diode, Special	755-404593	DI	755-404593	24
CR7	Diode, Silicon, 200 PIV, 250ma, Min.	755-834280	XX	G296	24
CR8	Diode, Silicon, 200 PIV, 250ma, Min.	755-834280	XX	G296	24
CR9	Diode, Silicon, 200 PIV, 250ma, Min.	755-834280	XX	G296	24
CR10	Diode, Silicon, 200 PIV, 250ma, Min.	755-834280	XX	G296	24
CR11	Diode, Silicon, 200 PIV, 250ma, Min.	755-834280	XX	G296	24
CR12	Diode, Zener, 8.2 Volts, 400 mw, 10%	755-822549	AL	1N756	24

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A2	METER BOARD ASSEMBLY (Continued)				
R1	Resistor, F. Film, 470 Ohms, 1/2 Watt, 5%	607-829696	DI	607-829696	24
R2	Resistor, F. Film, 3.9 K, 1/2 Watt, 5%	607-829718	DI	607-829718	24
R3	Resistor, V. W.W., 5 K, 1/4 Watt, 10%	611-810263	BC	275-1-502	24
R4	Resistor, F. Film, 2.2 K, 1/2 Watt, 5%	607-829712	DI	607-829712	24
R5	Resistor, F. Film, 1 K, 1/2 Watt, 5%	607-829704	DI	607-829704	24
R6	Resistor, V. Comp., 50 K, .2 Watt, 20%	614-834287	BC	276-1-503	24
R7	Resistor, F. Film, 91 K, 1 Watt, 5%	607-834234	DI	607-834234	24
R8	Resistor, F. Film, 4.7 K, 2 Watts, 5%	607-834237	DI	607-834237	24
R9	Resistor, F. Film, 4.7 K, 2 Watts, 5%	607-834237	DI	607-834237	24
R10	Resistor, V. W.W., 5 K, 1/4 Watt, 10%	611-810263	DI	611-810263	24
R11	Resistor, F. Film, 6.8 K, 1 Watt, 5%	607-834235	DI	607-834235	24
A3	CONTROL BOARD ASSEMBLY	887-419204	DI	887-419204	22,25
C1	Capacitor, F. Elect., 100mf, 6 Volts, 10%	631-810699	NN	TE1102	25
C2	Capacitor, F. Elect., 200mf, 6 Volts, 10%	631-827434	NN	TE1104	25
C3	Capacitor, F. Cerm. 1000pf, 1000 Volts	633-804706	H	DD-102	25
C4	Capacitor, F. Elect., 50mf, 6 Volts	631-816778	NN	TE1100	25
C5	Capacitor, F. Cerm. 1000 pf, 1000 Volts	633-804706	H	DD102	25
CR1	Diode, Germanium, 25 PIV, 200ma, 1 Volt	755-834283	V	1N283	25
CR2	Diode, Special	755-418189	DI	755-418189	25
CR3	Diode, Special	755-418189	DI	755-418189	25
CR4	Diode, Zener, 56 Volts, 1 Watt, 5%	755-834282	AL	1N3038B	25
CR5	Diode, Special	755-418189	DI	755-418189	25
CR6	Diode, Germanium, 25 PIV, 200ma, 1 Volt	755-834283	V	1N283	25
CR7	Diode, Special	755-418189	DI	755-418189	25
CR8	Diode, Special	755-418189	DI	755-418189	25
CR9	Diode, Special	755-418189	DI	755-418189	25
CR10	Diode, Special	755-418189	DI	755-418189	25
CR11	Diode, Special	755-418189	DI	755-418189	25
CR12	Diode, Special	755-418189	DI	755-418189	25
CR13	Diode, Special	755-418189	DI	755-418189	25

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A3	CONTROL BOARD ASSEMBLY (Continued)				
CR14	Diode, Silicon, 600 PIV, 1 Amp, Special	755-416842	DI	755-416842	25
Q1	Transistor, Special	755-417845	DI	755-417845	25
Q2	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	25
Q3	Transistor, Special	755-417845	DI	755-417845	25
Q4	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	25
Q5	Transistor, Special	755-417845	DI	755-417845	25
Q6	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	25
Q7	Transistor, Special	755-417845	DI	755-417845	25
Q8	Transistor, Germanium, PNP, 45 Volts, CEX, 7-1/2 Watts	755-821936	CP	2N1183	25
Q9	Transistor, Germanium, PNP, 45 Volts, CEX, 7-1/2 Watts	755-821936	CP	2N1183	25
Q10	Transistor, Germanium, PNP, 80 Volts, CEX, 7-1/2 Watts	755-822235	CP	2N1184B	25
R1 *	Resistor, F. Comp., 330 Ohms, 1/2 Watt, 5%	601-XXXXXX	B	EB3315	25
R2	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	25
R3	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	25
R4 *	Resistor, F. Comp., 68 Ohms, 1/2 Watt, 5%	601-XXXXXX	B	EB6805	25
R5	Resistor, F. Comp., 10 Ohms, 1/2 Watt, 5%	601-022946	B	EB1005	25
R6	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	25
R7	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	25
R8	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R9	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R10	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	25
R11	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	25
R12	Resistor, F. Comp., 22 K, 1/2 Watt, 5%	601-000565	B	EB2235	25
R13	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	25
R14	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R15	Resistor, F. Comp., 33 K, 1/2 Watt, 5%	601-015060	B	EB3335	25
R16	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25

* Factory Selected, Typical Value Shown

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code	Manufacturer's Part No.	Location Figure No.
A3	CONTROL BOARD ASSEMBLY (Continued)				
R17	Resistor, F. Comp., 2.2 K, 1/2 Watt, 5%	601-000897	B	EB2225	25
R18	Resistor, F. Comp., 8.2 K, 1/2 Watt, 5%	601-015044	B	EB8225	25
R19	Resistor, F. Comp., 22 K, 1/2 Watt, 5%	601-000565	B	EB2235	25
R20	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	25
R21	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R22	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R23	Resistor, F. Comp., 22 K, 1/2 Watt, 5%	601-000565	B	EB2235	25
R24	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	25
R25	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R26	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	25
R27	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	25
R28	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	25
R29	Resistor, F. Comp., 47 K, 1/2 Watt, 5%	601-015064	B	EB4735	25
R30	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	25
R31	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R32	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	25
R33	Resistor, F. Comp., 270 Ohms, 1/2 Watt, 5%	601-800011	B	EB2715	25
R34	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	25
R35	Resistor, F. Film, 47 Ohms, 2 Watts, 5%	607-834236	DI	607-834236	25
A4	AMPLIFIER #1 BOARD ASSEMBLY	887-419205	DI	887-419205	22,26
C1	Capacitor, F. Elect., 600mf, 6 Volts	631-834271	CW	APD112	26
C2	Capacitor, F. Paper, 2mf, 50 Volts, 20%	639-834279	CU	VX5A205	26
C3	Capacitor, F. Elect., 200mf, 6 Volts	631-827434	NN	TE1104	26
C4	Capacitor, F. Paper, 2mf, 50 Volts, 20%	639-834279	CU	VX5A205	26
C5	Capacitor, F. Elect., 100mf, 6 Volts, 10%	631-810699	NU	TE1102	26
C6	Capacitor, F. Paper, 2mf, 50 Volts, 20%	639-834279	CU	VX5A205	26
C7	Capacitor, F. Paper, 2mf, 50 Volts, 20%	639-834279	CU	VX5A205	26
C8	Capacitor, F. Dipped Mica, 510pf	637-819450	E	DM-15E-511J-300	21
CR1	Diode, Special	755-418189	DI	755-418189	26
CR2	Diode, Germanium, 60 PIV, 5ma, 1 Volt	755-834315	BE	1N126	26

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A4	AMPLIFIER #1 BOARD ASSEMBLY (Continued)				
CR3	Diode, Special	755-418189	DI	755-418189	26
CR4	Diode, Germanium, 60 PIV, 5ma, 1 Volt	755-834315	BE	1N126	26
CR5	Diode, Special	755-418189	DI	755-418189	26
Q1	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	26
Q2	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	26
Q3	Transistor, Special	755-417845	DI	755-417845	26
Q4	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	26
Q5	Transistor, Special	755-417845	DI	755-417845	26
Q6	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	26
R1	Resistor, F. Film, 3.9 K, 1/2 Watt, 5%	607-829718	DI	607-829718	26
R2	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	26
R3	Resistor, F. Comp., 33 K, 1/2 Watt, 5%	601-015060	B	EB3335	26
R4	Resistor, F. Film, 4.7 K, 1/2 Watt, 5%	607-829720	DI	607-829720	26
R5	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	26
R6	Resistor, F. Film, 150 K, 1/2 Watt, 5%	607-829761	DI	607-829761	26
R7	Resistor, F. Comp., 2.2 K, 1/2 Watt, 5%	601-000897	B	EB2225	26
R8	Resistor, F. Comp., 2.2 K, 1/2 Watt, 5%	601-000897	B	EB2225	26
R9	Resistor, F. Comp., 2.2 K, 1/2 Watt, 5%	601-000897	B	EB2225	26
R10	Resistor, F. Comp., 1.8 K, 1/2 Watt, 5%	601-015449	B	EB1825	26
R11	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	26
R12	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	26
R13	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	26
R14	Resistor, F. Comp., 1.8 K, 1/2 Watt, 5%	601-015449	B	EB1825	26
R15 *	Resistor, F. Comp., 39 K, 1/2 Watt, 5%	601-XXXXXX	B	EB3935	26
R16	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	26
R17	Resistor, F. Comp., 47 K, 1/2 Watt, 5%	601-015064	B	EB4735	26
R18 *	Resistor, F. Comp., 20 K, 1/2 Watt, 5%	601-XXXXXX	B	EB2035	26
R19	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	26
R20	Resistor, F. Comp., 15 K, 1/2 Watt, 5%	601-022948	B	EB1535	26

* Factory Selected, Typical Value Shown

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code	Manufacturer's Part No.	Location Figure No.
A4	AMPLIFIER #1 BOARD ASSEMBLY (Continued)				
R21	Resistor, F. Comp., 180 Ohms, 1/2 Watt, 5%	601-024744	B	EB1815	26
R22 *	Resistor, F. Comp., 43 K, 1/2 Watt, 5%	601-XXXXXX	B	EB4335	26
R23	Resistor, F. Comp., 100 K, 1/2 Watt, 5%	601-015074	B	EB1045	26
R24 *	Resistor, F. Comp., 8.2 K, 1/2 Watt, 5%	601-XXXXXX	B	EB8225	26
R25	Resistor, F. Comp., 56 K, 1/2 Watt, 5%	601-015068	B	EB5635	26
R26	Resistor, F. Comp., 33 K, 1/2 Watt, 5%	601-015060	B	EB3335	26
R27	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	26
R28	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	26
R29	Resistor, F. Comp., 1.5 K, 1/2 Watt, 5%	601-008129	B	EB1525	26
R30	Resistor, F. Comp., 1.5 K, 1/2 Watt, 5%	601-008129	B	EB1525	26
R31 *	Resistor, F. Comp., 39 K, 1/2 Watt, 5%	601-XXXXXX	B	EB3935	26
R32	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	26
R33	Resistor, F. Comp., 180 Ohms, 1/2 Watt, 5%	601-024744	B	EB1815	26
A5	AMPLIFIER #2 BOARD ASSEMBLY	887-419206	DI	887-419206	22,27
C1	Capacitor, F. Mylar, 0.1mf, 50 Volts, 20%	651-834276	CU	ZX5A104	27
C2	Capacitor, F. Elect., 50mf, 6 Volts, 10%	631-810305	NN	TE1100	27
C3	Capacitor, F. Elect., 100mf, 6 Volts, 10%	631-810699	NN	TE1102	27
C4	Capacitor, F. Mica, 470pf, 300 Volts, 5%	637-824024	E	DM16E471J-300	27
C5	Capacitor, F. Mylar, .022mf, 50 Volts	651-834275	CU	ZX5A223	27
C6	Capacitor, F. Elect., 20mf, 6 Volts, 10%	631-079424	AI	NLW-20-6	27
C7	Capacitor, F. Elect., 50mf, 6 Volts, 10%	631-810305	NN	TE1100	27
Q1	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	27
Q2	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	27
Q3	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	27
Q4	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	27
Q5	Transistor, Germanium, PNP, 200mw	755-810735	AL	2N652	27
R1	Resistor, F. Comp., 1.5K, 1/2 Watt, 5%	601-008129	B	EB1525	27
R2 *	Resistor, F. Comp., 1.1K, 1/2 Watt, 5%	601-XXXXXX	B	EB1125	27
R3	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	27
R4	Resistor, V. Comp., 50 K, .2 Watt, 20%	614-834287	BC	276-1-503	27

* Factory Selected, Typical Value Shown

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A5	AMPLIFIER #2 BOARD ASSEMBLY (Continued)				
R5	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	27
R6	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	27
R7	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	27
R8	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	27
R9	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	27
R10	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	27
R11	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	27
R12	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	27
R13	Resistor, F. Comp., 47 Ohms, 1/2 Watt, 5%	601-012028	B	EB4705	27
R14	Resistor, F. Comp., 1.2 K, 1/2 Watt, 5%	601-015039	B	EB1225	27
R15	Resistor, F. Comp., 47 Ohms, 1/2 Watt, 5%	601-012028	B	EB4705	27
R16	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	27
R17	Resistor, F. Comp., 1.2 K, 1/2 Watt, 5%	601-015039	B	EB1225	27
R18	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	27
R19	Resistor, F. Comp., 2.4 K, 1/2 Watt, 5%	601-015451	B	EB3225	27
A6	AMPLIFIER #3 BOARD ASSEMBLY	887-419207	DI	887-419207	22,28
C1	Capacitor, F. Elect., 50mf, 12 Volts	631-823117	NN	TE1133	28
C2	Capacitor, F. Cerm., 5000pf, 1000 Volts	633-804714	H	DD-5022	28
C3	Capacitor, F. Cerm., 5000pf, 1000 Volts	633-804714	H	DD-5022	28
CR1	Diode, Special	755-418189	DI	755-418189	28
CR2	Diode, Special	755-418189	DI	755-418189	28
CR3	Diode, Special	755-418189	DI	755-418189	28
CR4	Diode, Germanium, 60 PIV, 5ma, 1 Volt	755-834315	BE	1N126	28
CR5	Diode, Special	755-418189	DI	755-418189	28
CR6	Diode, Special	755-418189	DI	755-418189	28
CR7	Diode, Special	755-418189	DI	755-418189	28
CR8	Diode, Special	755-418189	DI	755-418189	28
CR9	Diode, Special	755-418189	DI	755-418189	28
CR10	Diode, Special	755-418189	DI	755-418189	28
CR11	Diode, Special	755-418189	DI	755-418189	28

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A6	AMPLIFIER #3 BOARD ASSEMBLY (Continued)				
CR12	Diode, Special	755-418189	DI	755-418189	28
Q1	Transistor, Special	755-417845	DI	755-417845	28
Q2	Transistor, Germanium, PNP, 50mw Max.	755-800397	CP	2N398	28
Q3	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	28
Q4	Transistor, Silicon, Type T.I. 481	755-834316	XX	481	28
Q5	Transistor, Silicon, Type T.I. 481	755-834316	XX	481	28
Q6	Transistor, Germanium, PNP, 250mw Max.	755-834317	XX	2N1998	28
Q7	Transistor, Germanium, PNP, 250mw Max.	755-834317	XX	2N1998	28
R1	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	28
R2	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	28
R3	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	28
R4	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	28
R5	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	28
R6	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	28
R7	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	28
R8	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	28
R9	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	28
R10	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	28
R11	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	28
R12	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	28
R13	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	28
R14	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	28
R15	Resistor, F. Comp., 2.2 K, 1/2 Watt, 5%	601-000897	B	EB2225	28
R16	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	28
R17	Resistor, F. Comp., 2.2 K, 1/2 Watt, 5%	601-000897	B	EB2225	28
R18	Resistor, F. Comp., 56 K, 1/2 Watt, 5%	601-015068	B	EB5635	28
R19	Resistor, F. Comp., 100 K, 1/2 Watt, 5%	601-015074	B	EB1045	28
R20	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	28
R21	Resistor, F. Comp., 3.3 K, 1/2 Watt, 5%	601-015460	B	EB3325	28
R22	Resistor, F. Comp., 10 Ohms, 1/2 Watt, 5%	601-022946	B	EB1005	28

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A6	AMPLIFIER #3 BOARD ASSEMBLY (Continued)				
R23	Resistor, F. Comp., 10 Ohms, 1/2 Watt, 5%	601-022946	B	EB1005	28
A7	REFERENCE #1 BOARD ASSEMBLY	887-419208	DI	887-419208	22,29
C1	Capacitor, F. Paper, 1.5mf, 50 Volts, 20%	639-834278	CU	VX5A155	29
C2	Capacitor, F. Paper, 1.5mf, 50 Volts, 20%	639-834278	CU	VX5A155	29
C3	Capacitor, F. Polyst., .33mf, 50 Volts	651-834273	CU	PD-2253	29
C4 *	Capacitor, F. Polyst., 0.01mf, 50 Volts	651-XXXXXX	CU	PD-XXXX	29
C5 *	Capacitor, F. Polyst., 0.033mf, 50 Volts	651-XXXXXX	CU	PD-XXXX	29
C6 *	Capacitor, F. Polyst., 0.25mf, 50 Volts	651-XXXXXX	CU	PD-XXXX	29
C7	Capacitor, F. Polyst., 1.1mf, 50 Volts	651-834274	CU	PD-2273	29
CR1	Diode, Special	755-418189	DI	755-418189	29
CR2	Diode, Special	755-418189	DI	755-418189	29
CR3	Diode, Zener, 4.85 Volts Min. 5.36 Volts Max., 20ma	755-818496	AL	1N751A	29
CR4	Diode, Special	755-418189	DI	755-418189	29
Q1	Transistor, Special	755-417845	DI	755-417845	29
Q2	Transistor, Special	755-417845	DI	755-417845	29
Q3	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	29
Q4	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	29
Q5	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	29
Q6	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	29
R1	Resistor, F. Comp., 820 Ohms, 1/2 Watt, 5%	601-079172	B	EB8215	29
R2	Resistor, V. W.W., 1 K, 1/4 Watt, 5%	611-810696	BC	275-1-102	29
R3	Resistor, F. Comp., 1.8 K, 1/2 Watt, 5%	601-015449	B	EB1825	29
R4	Resistor, F. Comp., 560 Ohms, 1/2 Watt, 5%	601-079492	B	EB5615	29
R5	Resistor, F. Comp., 3.9 K, 1/2 Watt, 5%	601-015047	B	EB3925	29
R6	Resistor, F. Comp., 10 K, 1/2 Watt, 5%	601-015052	B	EB1035	29
R7 *	Resistor, F. Comp., 1 Meg., 1/2 Watt, 5%	601-XXXXXX	B	EB1055	29
R8	Resistor, F. Film, 470 Ohms, 1/2 Watt, 5%	607-829696	DI	607-829696	29
R9 *	Resistor, F. Comp., 18 Ohms, 1/2 Watt, 5%	607-XXXXXX	B	EB1805	29

* Factory Selected, Typical Value Shown

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A7	REFERENCE #1 BOARD ASSEMBLY (Continued)				
R10	Resistor, F. Film, 470 Ohms, 1/2 Watt, 5%	607-829696	DI	607-829696	29
R11	Resistor, F. Film, 18 Ohms, 1/2 Watt, 5%	607-834238	DI	607-834238	29
R12	Resistor, F. Film, 10 Ohms, 1/2 Watt, 5%	607-834239	DI	607-834239	29
R13	Resistor, F. Film, 150 Ohms, 1/2 Watt, 5%	607-829683	DI	607-829683	29
R14 *	Resistor, F. Film, 250 Ohms, 1/2 Watt, 5%	607-XXXXXX	DI	607-XXXXXX	29
R15	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	29
R16	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	601-015038	29
R17	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	29
A8	REFERENCE #2 BOARD ASSEMBLY	887-419209	DI	887-419209	22,30
C1 *	Capacitor, F. Polyst., 0.22mf, 50 Volts	651-XXXXXX	CU	PD-XXXX	30
C2 *	Capacitor, F. Polyst., 0.018mf, 50 Volts	651-XXXXXX	CU	PD-XXXX	30
C3 *	Capacitor, F. Polyst., 0.01mf, 50 Volts	651-XXXXXX	CU	PD-XXXX	30
C4	Capacitor, F. Polyst., .33mf, 50 Volts	651-834273	CU	PD-2253	30
C5	Capacitor, F. Elect., 20mf, 6 Volts	631-079424	AI	NLW-20-6	30
CR1	Diode, Special	755-418189	DI	755-418189	30
Q1	Transistor, Germanium, PNP, 250mw Max.	755-811276	XX	2N1374	30
Q2	Transistor, Germanium, PNP, 250mw Max.	755-811276	XX	2N1374	30
Q3	Transistor, Germanium, PNP, 250mw Max.	755-811276	XX	2N1374	30
Q4	Transistor, Germanium, PNP, 250mw Max.	755-811276	XX	2N1374	30
Q5	Transistor, Germanium, PNP, 250mw Max.	755-811276	XX	2N1374	30
Q6	Transistor, Germanium, PNP, 250mw Max.	755-811276	XX	2N1374	30
R1	Resistor, F. Film, 3.3 K, 1/2 Watt, 5%	607-829716	DI	607-829716	30
R2	Resistor, F. Film, 330 Ohms, 1/2 Watt, 5%	607-829692	DI	607-829692	30
R3	Resistor, F. Film, 3.3 K, 1/2 Watt, 5%	607-829716	DI	607-829716	30
R4 *	Resistor, F. Film, 3.3 K, 1/2 Watt, 5%	607-XXXXXX	DI	607-XXXXXX	30
R5	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	30
R6 *	Resistor, F. Film, 560 Ohms, 1/2 Watt, 5%	607-XXXXXX	DI	607-XXXXXX	30
R7	Resistor, F. Film, 150 Ohms, 1/2 Watt, 5%	607-829683	DI	607-829683	30
R8	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	30

* Factory Selected, Typical Value Shown

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A8	REFERENCE #2 BOARD ASSEMBLY (Continued)				
R9	Resistor, V. W.W., 1 K, 1/4 Watt, 10%	611-810696	BC	275-1-102	30
R10	Resistor, V. W.W., 2 K, 1/4 Watt, 10%	611-806222	BC	275-1-202	30
R11	Resistor, F. Film, 3.3 K, 1/2 Watt, 5%	607-829716	DI	607-829716	30
R12	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	30
R13	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	30
A9	POWER SUPPLY #2 BOARD ASSEMBLY	855-419211	DI	855-419211	22,31
C1	Capacitor, F. Elect., 20mf, 6 Volts, 10%	631-079424	AI	NLW-20-6	31
C2	Capacitor, F. Mylar, 0.1mf, 50 Volts	651-834276	CU	ZX5A104	31
C3	Capacitor, F. Elect., 20mf, 15 Volts	631-802895	NN	TE1157	31
CR1	Diode, Rectifier, Special	755-416842	DI	755-416842	31
CR2	Diode, Rectifier, Special	755-416842	DI	755-416842	31
CR3	Diode, Zener, 11 Volts, ± 10%	755-834285	AL	1N962A	31
CR4	Diode, Rectifier, Special	755-416842	DI	755-416842	31
CR5	Diode, Rectifier, Special	755-416842	DI	755-416842	31
CR6	Diode, Rectifier, Special	755-416842	DI	755-416842	31
CR7	Diode, Rectifier, Special	755-834285	DI	755-416842	31
CR8	Diode, Special	755-418189	DI	755-418189	31
Q1	Transistor, Germanium, PNP, 90 Watts	755-834286	AL	2N1531	31
Q2	Transistor, Germanium, PNP, 90 Watts	755-822107	AL	2N1544	31
Q3	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	31
Q4	Transistor, Germanium, PNP, 250mw	755-811276	XX	2N1374	31
Q5	Transistor, Germanium, NPN, 150mw	755-810617	AK	2N1304	31
Q6	Transistor, Germanium, PNP, 90 Watts	755-822107	AL	2N1544	31
R1	Resistor, F. W.W., 1.5 Ohms, 3 Watts, 5%	604-834288	CM	3 x 1.5	31
R2	Resistor, F. Comp., 820 Ohms, 1/2 Watt, 5%	601-079172	B	EB8215	31
R3	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	31
R4	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	31
R5	Resistor, F. Comp., 470 Ohms, 1/2 Watt, 5%	601-015446	B	EB4715	31
R6	Resistor, F. Comp., 220 Ohms, 1/2 Watt, 5%	601-022939	B	EB2215	31

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A9	POWER SUPPLY #2 BOARD ASSEMBLY (Continued)				
R7 *	Resistor, F. Comp., 82 Ohms, 1/2 Watt, 5%	601-XXXXXX	B	EB8205	31
R8	Resistor, F. Comp., 560 Ohms, 1/2 Watt, 5%	601-079492	B	EB5615	31
R9	Resistor, F. Comp., 1 K, 1/2 Watt, 5%	601-015038	B	EB1025	31
R10	Resistor, F. Comp., 100 Ohms, 1/2 Watt, 5%	601-022930	B	EB1015	31
R11	Resistor, F. Comp., 22 Ohms, 1/2 Watt, 5%	601-800005	B	EB2205	31
R12	Resistor, F. Comp., 330 Ohms, 1/2 Watt, 5%	601-015443	B	EB3315	31
R13	Resistor, F. Comp., 560 Ohms, 1/2 Watt, 5%	601-079492	B	EB5615	31
R14 *	Resistor, F. Comp., 18 K, 1/2 Watt, 5%	601-XXXXXX	B	EB1835	31
R15	Resistor, F. Comp., 47 Ohms, 1/2 Watt, 5%	601-012028	B	EB4705	31
A10	POWER SUPPLY #3 BOARD ASSEMBLY	855-419210	DI	855-419210	22,32
C1	Capacitor, F. Elect., 2000mf, 20 Volts	631-834270	CW	EIA-911	32
C2	Capacitor, F. Elect., 2000mf, 20 Volts	631-834270	CW	EIA-911	32
C3	Capacitor, F. Elect., 2000mf, 20 Volts	631-834270	CW	EIA-911	32
C4	Capacitor, F. Elect., 2000mf, 20 Volts	631-834270	CW	EIA-911	32
C5	Capacitor, F. Elect., 2000mf, 20 Volts	631-834270	CW	EIA-911	32
C6	Capacitor, F. Elect., 2000mf, 20 Volts	631-834270	CW	EIA-911	32
CR1	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR2	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR3	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR4	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR5	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR6	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR7	Diode, Special Rectifier	755-416842	DI	755-416842	32
CR8	Diode, Special Rectifier	755-416842	DI	755-416842	32
R1	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	32
R2	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	32
R3	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	32
R4	Resistor, F. Comp., 4.7 K, 1/2 Watt, 5%	601-000899	B	EB4725	32

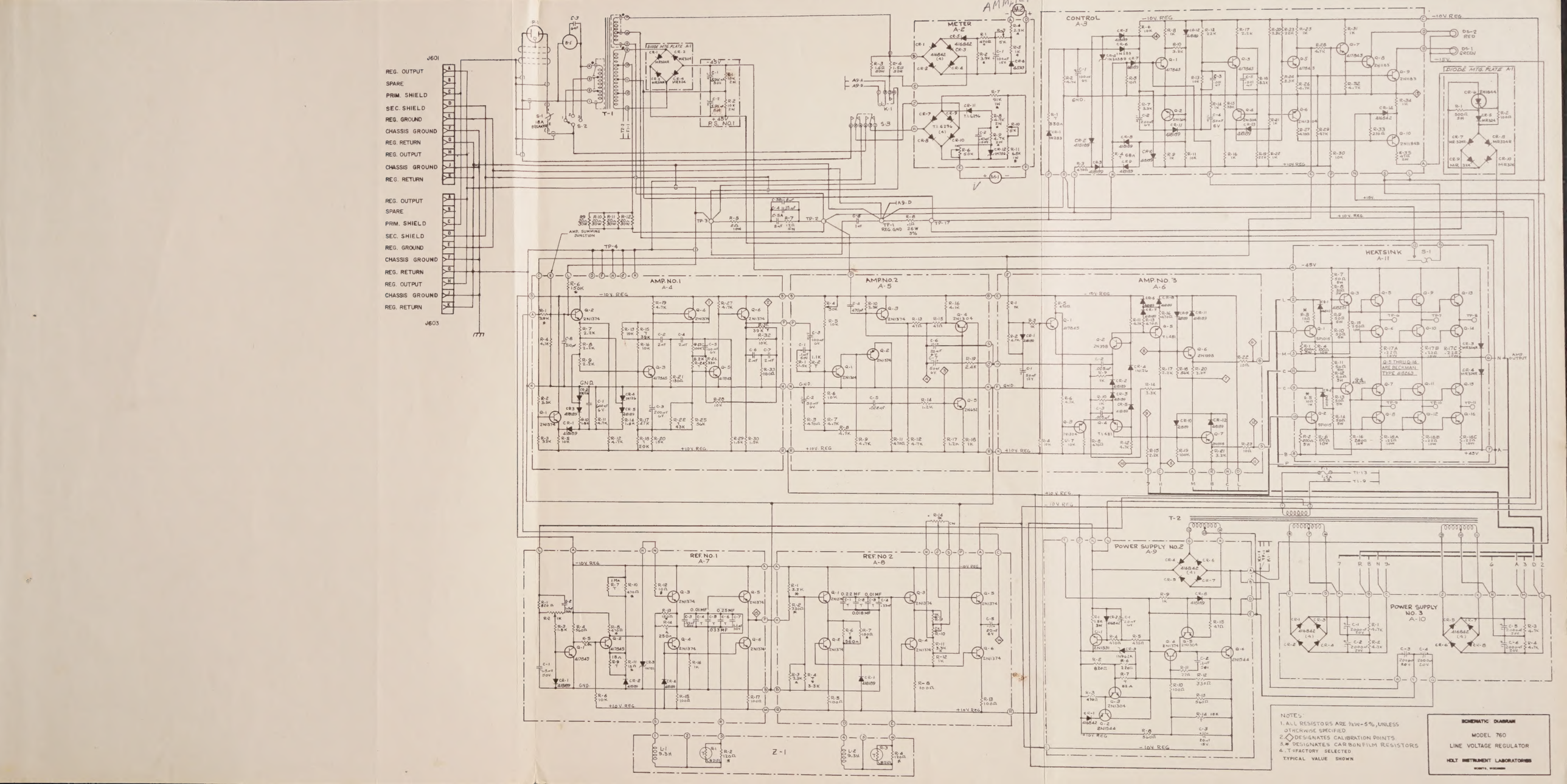
* Factory Selected, Typical Value Shown

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
A11	HEATSINK ASSEMBLY	855-419220	DI	855-419220	22,33
CR1	Diode, Silicon, 600 PIV, 1 Amp., Special	755-416842	DI	755-416842	33
CR2	Diode, Silicon, 600 PIV, 1 Amp., Special	755-416842	DI	755-416842	33
CR3	Rectifier, Silicon, Type MR324R	755-829376	AL	MR324R	33
CR4	Rectifier, Silicon, Type MR324R	755-829376	AL	MR324R	33
P1	Connector, Rectangular, 12 Male Contacts	672-834309	BW	261-11-12-020	33
Q1	Transistor, Germanium, PNP, Power	755-834318	AL	SP1015	33
Q2	Transistor, Germanium, PNP, Power	755-834318	AL	SP1015	33
Q3	Transistor, Germanium, Special	755-418251	DI	755-418251	33
Q4	Transistor, Germanium, Special	755-418251	DI	755-418251	33
Q5	Transistor, Special	755-418263	DI	755-418263	33
Q6	Transistor, Special	755-418263	DI	755-418263	33
Q7	Transistor, Special	755-418263	DI	755-418263	33
Q8	Transistor, Special	755-418263	DI	755-418263	33
Q9	Transistor, Special	755-418263	DI	755-418263	33
Q10	Transistor, Special	755-418263	DI	755-418263	33
Q11	Transistor, Special	755-418263	DI	755-418263	33
Q12	Transistor, Special	755-418263	DI	755-418263	33
Q13	Transistor, Special	755-418263	DI	755-418263	33
Q14	Transistor, Special	755-418263	DI	755-418263	33
Q15	Transistor, Special	755-418263	DI	755-418263	33
Q16	Transistor, Special	755-418263	DI	755-418263	33
R1	Resistor, F. W.W., 200 Ohms, 5 Watts, 5%	604-005637	CM	5XM200	33
R2	Resistor, F. W.W., 200 Ohms, 5 Watts, 5%	604-005637	CM	5XM200	33
R3	Resistor, F. Film, 10 Ohms, 1 Watt, 5%	607-834310	DI	607-834310	33
R4	Resistor, F. W.W., 100 Ohms, 10 Watts, 5%	604-834313	CM	10XM100	33
R5	Resistor, F. Film, 10 Ohms, 1 Watt, 5%	607-834310	DI	607-834310	33
R6	Resistor, F. W.W., 100 Ohms, 10 Watts, 5%	604-834313	CM	10XM100	33
R7	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM	5XM50	33
R8	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM	5XM50	33
R9	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM	5XM50	33

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.	Location Figure No.
A11	HEATSINK ASSEMBLY (Continued)			
R10	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM 5XM50	33
R11	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM 5XM50	33
R12	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM 5XM50	33
R13	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM 5XM50	33
R14	Resistor, F. W.W., 50 Ohms, 5 Watts, 5%	604-834312	CM 5XM50	33
R15	Resistor, F. W.W., 250 Ohms, 10 Watts, 5%	604-834311	CM 10XM250	33
R16	Resistor, F. W.W., 250 Ohms, 10 Watts, 5%	604-834311	CM 10XM250	33
R17	Resistor, F. W.W., Set, 3 x .225 Ohms, 10 W.	755-418252	DI 755-418252	33
R18	Resistor, F. W.W., Set, 3 x .225 Ohms, 10 W.	755-418252	DI 755-418252	33
S1	Thermostat, Open at 130° F., ± 5° F. Close at 150° F., ± 5° F.	805-418935	DI 805-418935	33
	REGULATOR CHASSIS ASSEMBLY			
B1	Fan, 3300 RPM, 125 CFM at 115 V, 60 CPS	241-817284	CX Model 1000	4
C1	Capacitor, F. Elect., 5900mf, 50 Volts, DC	631-829867	NN 36D3112T	21
C2	Capacitor, F. Elect., 5900mf, 50 Volts, DC	631-829867	NN 631-829867	21
C3	Capacitor, F. Paper, 6mf, 220 WVAC, 10%	639-824630	CY KO/MP34/6D220/1	22
C4	Capacitor, F. Elect., 15mf, 150 Volts	631-419132	DI 631-419132	21
C5	Capacitor, Filter, 3 x 8mf	641-418873	DI 641-418873	21
C6	Capacitor, F. Paper, 1mf, 200 Volts	639-006773	CZ 1P2D	21
DS1	Lamp, Incandescent, 14 Volts, .08A Min.	825-829283	DA 330L	3
DS2	Lamp, Incandescent, 14 Volts, .08A Min.	825-829283	DA 330L	3
F1	Fuse, Electrical, 1.5 Amp. 125 Volts, Time Delay	731-801567	BB 31301.5	21
J601	Connector, 10 Pin	* 1701-037	CQ DTK-00-12-10SW	4
J603	Connector, 10 Pin	* 1701-036	CQ DTK-00-12-10S	4
K1	Relay, 12 Volts, Heavy Duty Open, 75 Ohms, 10%	718-829864	DH KD-3D	22
M1	AC Voltmeter	813-418913	DI 813-418913	3
M2	AC Ammeter	809-418914	DI 809-418914	3
P1	Connector, Power, 3 Wire Grounding Plug	676-834474	DB 5267	22
R1	Resistor, F. Comp., 10 K, 2 Watts, 5%	601-015053	B HB1035	21

* Holt Part Number

Circuit Reference	Description	Beckman Part No.	Manufacturer's Code and Part No.		Location Figure No.
	REGULATOR CHASSIS ASSEMBLY (Continued)				
R2	Resistor, F. Comp., 10 K, 2 Watts, 5%	601-015053	B	HB1035	21
R3	Resistor, F. W.W., 1.5 Ohms, 50 Watts, 1%	604-829871	AZ	RH-50	21
R4	Resistor, F. W.W., 1.5 Ohms, 50 Watts, 1%	604-829871	AZ	RH-50	21
R5	Resistor, F. W.W., 2 Ohms, 10 Watts, 1%	604-835066	NN	247E2R05	21
R7	Resistor, F. W.W., 12 Ohms, 5 Watts	604-829873	CM	RW-55	21
R8	Resistor, F. W.W., 0.1 Ohm, 9.6 Watts, 3%	604-829872	DE	SAV-96	21
R9	Resistor, F. W.W., 20 Ohms, 50 Watts, 1%	604-023329	AZ	RH-50	22
R10	Resistor, F. W.W., 20 Ohms, 50 Watts, 1%	604-023329	AZ	RH-50	22
R11	Resistor, F. W.W., 20 Ohms, 50 Watts, 1%	604-023329	AZ	RH-50	22
R12	Resistor, F. W.W., 20 Ohms, 50 Watts, 1%	604-023329	AZ	RH-50	22
R14	Resistor, V. W.W., 1 K, 2 Watts, 10%	611-815095	BA	43-1000	3
S1	Circuit Breaker, Magnetic, 18 Amps, 240 Volts, Curve 65, 60 Cycles	739-834303	DF	VP3	3
S2	Switch, Rotary, 3 Pole, 1 Section, 2-5 Position	711-834396	H	JV-9003	4
S3	Switch, Pushbutton, DPDT, 3 Amps	704-829914	JJ	4006	3
T1	Transformer, Isolation	792-418967	DI	792-418967	22
T2	Transformer, Power, Spec.	792-418912	DI	792-418912	21
XA3 thru XA8	Connector, Printed Circuit, 15 Contacts	680-824871	BW	250-15-70-170	21
Z1	Inductor, Special	792-418856	DI	792-418856	21


J601
REG. OUTPUT
SPARE
PRIM. SHIELD
SEC. SHIELD
REG. GROUND
CHASSIS GROUND
REG. RETURN
REG. OUTPUT
CHASSIS GROUND
REG. RETURN
J603
REG. OUTPUT
SPARE
PRIM. SHIELD
SEC. SHIELD
REG. GROUND
CHASSIS GROUND
REG. RETURN
REG. OUTPUT
CHASSIS GROUND
REG. RETURN
METER A-2
CONTROL A-3
AMP. NO. 1 A-4
AMP. NO. 2 A-5
AMP. NO. 3 A-6
REF. NO. 1 A-7
REF. NO. 2 A-8
POWER SUPPLY NO. 2 A-9
POWER SUPPLY NO. 3 A-10
HEATSINK A-11
T-1
T-2
Z-1
-10V REG
+10V REG
-45V
+45V
-15V
+15V
GND
AMP. SUMMING JUNCTION
DIODE MTG. PLATE A-1
DIODE MTG. PLATE A-2
B.S. NO. 1
NOTES:
1. ALL RESISTORS ARE ½W-5%, UNLESS OTHERWISE SPECIFIED
2. ◇ DESIGNATES CALIBRATION POINTS
3. ✱ DESIGNATES CARBON FILM RESISTORS
4. T FACTORY SELECTED
TYPICAL VALUE SHOWN
SCHEMATIC DIAGRAM
MODEL 760
LINE VOLTAGE REGULATOR
HOLT INSTRUMENT LABORATORIES